



*MiniSShot*

## MiniSShot Trajectory Study using SOAR

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## **Introduction**

This study is intended to complement the trajectory study done earlier by Hans Olaf Toft “MiniSShot Trajectory Study” [1]. That study utilized two software packages, primarily “Launch” and as a check of results, “RASAero”. The goal of the study was to predict a range of expected apogee for the upcoming MiniSShot flight, using known vehicle parameters in combination with reasonable assumptions as required.

The current study utilizes SOAR, a software written by the author in collaboration with Blair W. Nakka. SOAR is a 1-D trajectory analysis that inputs basic vehicle parameters and motor thrust data based on measured static test results. Multi-stage rocket simulations are supported. The dual-phase nature of MiniSShot was handled by treating the vehicle as a two-stage rocket, with the dry mass of the first stage being equal to the Delay Plug mass. For this study, runs were done in both US and metric units of measure.

The goal of this study is to provide a brief comparison and affirmation of the results of reference 1.

## **Analysis**

The SOAR simulations used the following MiniSShot vehicle input parameters:

### 1<sup>st</sup> Stage

Body diameter	3.55 inch	9.02 cm
Dry mass	0.383 lbm	0.174 kg

### 2<sup>nd</sup> Stage

Body diameter	3.55 inch	9.02 cm
Dry mass	19.0 lbm	8.62 kg

Two different vehicle drag models were considered. One drag model used the SOAR built-in function applicable to a “sharp” nosecone. For comparison, a second scenario considered the drag coefficient values derived from AeroLab, as used in reference 1. For the latter, “power-on” drag was used up to a velocity of Mach 1. Average Cd values for power-on and power-off flight were used for velocities greater than Mach 1. The two different drag models are illustrated in Figure 1.

The delay period between burnout of the 1<sup>st</sup> phase and thrust initiation of the 2<sup>nd</sup> phase was taken to be 11 seconds (i.e. second phase thrust commences at 14.915 seconds into flight).

### Reference:

[1] [http://sugarshot.org/downloads/minisshot\\_trajectory\\_study\\_20091115.pdf](http://sugarshot.org/downloads/minisshot_trajectory_study_20091115.pdf)

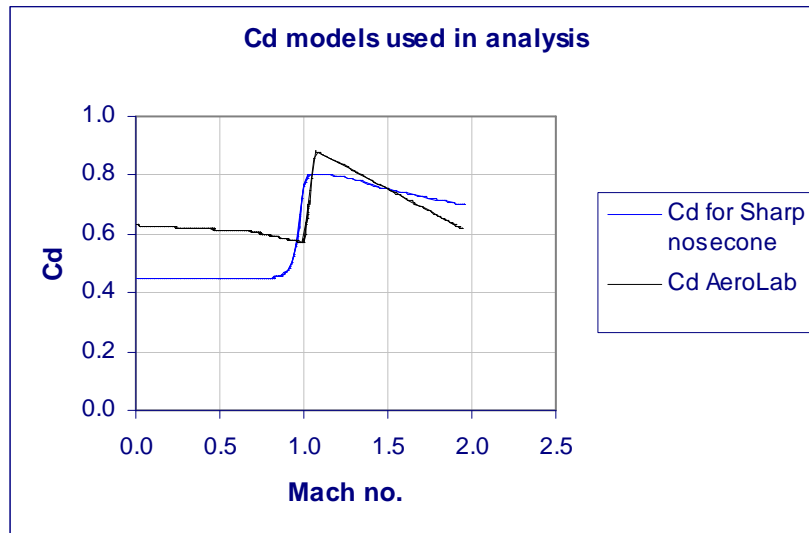


Figure 1 – Drag models used in analysis

## **Results**

Two SOAR runs were performed, one using the “sharp nosecone” built-in Cd versus Mach drag model, and the other using the AeroLab Cd versus Mach drag model. The runs were done in both US customary units and in metric units, for a total of four runs. The results are summarized below. Complete results are presented in Appendices A-D.

<b>Drag Model</b>	<b>Apogee (feet AGL)</b>	<b>Apogee (metres AGL)</b>
Sharp nosecone (SOAR built-in)	40727	12408
AeroLab	39667	12084

## **Conclusions**

The results are in agreement with the lower-end apogee estimates of reference 1. Due to certain limitations of the SOAR software, such as inability to change launch site ground elevation and ground-level temperature (15°C is assumed), the results can be expected to be slightly conservative with regard to apogee predictions.

**Appendix A**  
**SOAR Output, “Sharp Nosecone” Cd, US customary units**

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SOAR Output File: SOAR700.OUT                               Opt:1
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Stage 1  Computed Propellant Specific Impulse =           131.5  lb-sec/lb
Stage 1  Computed Engine Total Impulse =                 1516.9  lb-sec
Stage 2  Computed Propellant Specific Impulse =           136.9  lb-sec/lb
Stage 2  Computed Engine Total Impulse =                 1585.4  lb-sec

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Stage 1:

Time sec.	Thrust lb.	Altitude feet	Velocity ft/sec.	Acceleration ft/sec2	Mass lb.	Dyn.Press. lb/ft2	Drag lb.
.000	.0	1653.3	.00	-32.18	42.50	293.3	.0
.083	56.0	1653.2	-2.68	10.24	42.48	.0	.0
.167	60.0	1653.0	-1.83	13.31	42.44	.0	.0
.250	234.0	1652.9	-.72	145.61	42.35	.0	.0
.333	426.0	1653.4	11.41	293.08	42.14	.1	.0
.417	536.0	1655.4	35.82	380.02	41.84	1.5	.0
.500	488.0	1659.7	67.48	345.95	41.51	5.2	.2
.583	472.0	1666.5	96.29	336.11	41.21	10.5	.3
.666	477.0	1675.7	124.28	342.58	40.91	17.5	.5
.750	473.0	1687.2	152.81	341.97	40.61	26.4	.8
.833	465.0	1701.1	181.28	338.08	40.31	37.1	1.1
.916	466.0	1717.4	209.43	341.31	40.01	49.6	1.5
1.000	468.0	1736.0	237.85	345.35	39.72	63.9	2.0
1.083	480.0	1757.0	266.60	357.61	39.42	80.2	2.5
1.166	478.0	1780.5	296.37	358.51	39.11	99.0	3.1
1.250	483.0	1806.4	326.21	365.18	38.81	119.9	3.7
1.333	477.0	1834.9	356.61	362.71	38.51	143.2	4.4
1.416	493.0	1865.8	386.79	378.71	38.20	168.3	5.2
1.499	489.0	1899.3	418.31	377.94	37.89	196.6	6.1
1.583	488.0	1935.5	449.76	379.66	37.58	227.1	7.0
1.666	488.0	1974.3	481.35	382.20	37.27	259.8	8.0
1.749	488.0	2015.7	513.15	384.72	36.96	294.9	9.1
1.833	481.0	2059.8	545.15	381.05	36.65	332.4	10.3
1.916	483.0	2106.5	576.85	385.22	36.35	371.6	11.5
1.999	485.0	2155.9	608.89	389.40	36.04	413.5	12.8
2.082	480.0	2208.0	641.28	387.27	35.73	457.9	14.2
2.166	478.0	2262.7	673.48	387.74	35.43	504.2	15.6
2.249	476.0	2320.2	705.73	388.18	35.13	552.7	17.1
2.332	469.0	2380.3	738.00	383.88	34.83	603.4	18.6
2.416	477.0	2443.1	769.92	393.44	34.53	655.5	20.2
2.499	469.0	2508.6	802.63	388.03	34.23	711.0	22.0
2.582	456.0	2576.8	834.88	377.66	33.94	767.7	23.7
2.666	454.0	2647.7	866.27	377.54	33.65	824.8	25.5
2.749	443.0	2721.1	897.64	368.59	33.36	883.7	27.4
2.832	437.0	2797.2	928.27	364.19	33.09	942.9	29.4
2.916	418.0	2875.8	958.52	346.66	32.81	1003.0	31.6
2.999	416.0	2956.8	987.29	345.24	32.55	1061.5	34.2
3.082	395.0	3040.3	1015.92	323.90	32.29	1121.2	37.6
3.165	383.0	3126.0	1042.71	309.64	32.05	1178.1	42.5
3.249	372.0	3213.9	1068.20	293.03	31.81	1233.1	50.5
3.332	335.0	3303.9	1092.10	243.97	31.58	1285.5	63.9
3.415	266.0	3395.7	1112.08	168.06	31.39	1329.3	70.6
3.499	210.0	3488.9	1125.94	107.89	31.24	1358.8	74.0
3.582	151.0	3583.1	1134.84	45.55	31.13	1376.5	75.8
3.665	102.0	3677.8	1138.62	-5.33	31.05	1381.8	76.1
3.749	57.0	3772.6	1138.19	-51.71	31.00	1376.8	75.8
3.832	32.0	3867.2	1133.91	-76.89	30.97	1362.6	75.0
3.915	.0	3961.4	1127.56	-108.67	30.96	1343.6	73.6

4.415	.0	4512.2	1077.29	-89.03	30.96	1206.4	54.7
4.915	.0	5040.5	1037.25	-73.74	30.96	1100.7	40.0
5.415	.0	5550.3	1002.20	-67.15	30.96	1011.8	33.6
5.915	.0	6043.2	969.68	-63.21	30.96	933.1	29.9
6.415	.0	6520.2	938.82	-60.34	30.96	862.0	27.1
6.915	.0	6982.2	909.26	-58.00	30.96	797.3	24.8
7.415	.0	7429.7	880.78	-55.97	30.96	737.9	22.9
7.915	.0	7863.1	853.25	-54.16	30.96	683.3	21.2
8.415	.0	8283.1	826.59	-52.52	30.96	633.0	19.6
8.915	.0	8689.9	800.71	-51.01	30.96	586.6	18.1
9.415	.0	9083.9	775.56	-49.62	30.96	543.6	16.8
9.915	.0	9465.5	751.07	-48.34	30.96	503.8	15.6
10.415	.0	9835.1	727.20	-47.16	30.96	466.8	14.4
10.915	.0	10192.8	703.90	-46.05	30.96	432.5	13.4
11.415	.0	10539.1	681.13	-45.03	30.96	400.6	12.4
11.915	.0	10874.0	658.86	-44.08	30.96	370.9	11.5
12.415	.0	11198.0	637.04	-43.21	30.96	343.2	10.6
12.915	.0	11511.1	615.64	-42.38	30.96	317.4	9.8
13.415	.0	11813.7	594.65	-41.60	30.96	293.3	9.1
13.915	.0	12105.9	574.03	-40.88	30.96	270.8	8.4
14.415	.0	12387.8	553.76	-40.20	30.96	249.7	7.7
14.915	.0	12659.7	533.82	-39.57	30.96	230.1	7.1

Stage 2:

Time sec.	Thrust lb.	Altitude feet	Velocity ft/sec.	Acceleration ft/sec2	Mass lb.	Dyn.Press. lb/ft2	Drag lb.
14.915	.0	12659.7	533.82	-39.66	30.58	180.0	7.1
14.998	24.0	12704.0	530.52	-14.30	30.57	226.9	7.0
15.082	22.0	12748.1	529.33	-16.36	30.55	225.6	7.0
15.165	20.0	12792.2	527.97	-18.41	30.54	224.1	6.9
15.248	30.0	12836.1	526.44	-7.81	30.53	222.5	6.9
15.332	108.0	12879.9	525.79	74.58	30.48	221.6	6.9
15.415	192.0	12924.0	531.99	163.66	30.39	226.6	7.0
15.498	332.0	12968.9	545.61	313.30	30.23	238.0	7.4
15.582	467.0	13015.4	571.68	460.17	29.99	260.9	8.1
15.665	528.0	13064.6	609.96	530.10	29.69	296.5	9.2
15.748	568.0	13117.3	654.06	578.87	29.36	340.4	10.5
15.831	586.0	13173.7	702.21	604.47	29.00	391.6	12.1
15.915	598.0	13234.3	752.48	623.96	28.64	448.8	13.9
15.998	612.0	13299.2	804.36	646.20	28.28	511.8	15.8
16.081	606.0	13368.4	858.09	645.75	27.91	581.1	18.0
16.165	589.0	13442.1	911.76	631.89	27.54	654.5	20.5
16.248	593.0	13520.3	964.25	641.40	27.18	730.2	23.9
16.331	582.0	13602.8	1017.38	628.53	26.83	810.8	31.1
16.414	594.0	13689.7	1068.93	632.47	26.47	892.5	47.2
16.498	577.0	13780.9	1121.22	612.36	26.11	979.1	53.9
16.581	569.0	13876.5	1171.98	605.08	25.76	1066.5	58.7
16.664	554.0	13976.2	1222.13	588.51	25.42	1156.0	63.6
16.748	552.0	14080.0	1270.90	588.17	25.09	1245.9	68.3
16.831	541.0	14187.9	1319.65	576.09	24.75	1338.6	73.0
16.914	529.0	14299.8	1367.39	562.44	24.43	1432.0	77.6
16.998	518.0	14415.7	1414.00	549.89	24.11	1525.6	81.8
17.081	501.0	14535.4	1459.58	528.93	23.80	1619.2	86.0
17.164	485.0	14658.8	1503.42	508.80	23.50	1711.1	89.9
17.247	470.0	14785.8	1545.59	489.42	23.21	1801.0	93.8
17.331	456.0	14916.2	1586.13	470.64	22.93	1888.7	97.7
17.414	449.0	15050.0	1625.11	461.41	22.65	1974.0	101.5
17.497	431.0	15186.9	1663.33	436.08	22.38	2058.8	105.2
17.581	426.0	15327.0	1699.44	429.24	22.12	2139.4	108.7
17.664	416.0	15470.0	1734.99	414.87	21.87	2219.4	112.2
17.747	407.0	15616.0	1769.35	401.75	21.62	2297.2	115.5
17.831	393.0	15764.8	1802.61	380.85	21.37	2372.8	118.6
17.914	380.0	15916.2	1834.15	361.15	21.14	2444.4	121.6
17.997	364.0	16070.3	1864.06	336.55	20.91	2512.1	124.3

18.080	349.0	16226.7	1891.93	313.19	20.70	2574.5	126.8
18.164	331.0	16385.4	1917.87	284.84	20.49	2631.8	129.1
18.247	322.0	16546.1	1941.47	270.53	20.29	2682.8	131.1
18.330	300.0	16708.8	1963.89	235.24	20.10	2730.4	132.9
18.414	289.0	16873.2	1983.38	217.50	19.92	2769.8	134.4
18.497	273.0	17039.2	2001.41	191.50	19.75	2805.0	135.7
18.580	256.0	17206.6	2017.29	163.73	19.59	2834.0	136.7
18.664	242.0	17375.2	2030.88	140.85	19.44	2856.3	137.5
18.747	203.0	17544.8	2042.58	76.19	19.30	2873.1	138.0
18.830	158.0	17715.2	2048.93	1.54	19.19	2874.7	137.9
18.913	107.0	17885.9	2049.12	-82.84	19.11	2858.9	137.1
18.997	66.0	18056.3	2042.32	-149.56	19.06	2823.9	135.5
19.080	39.0	18225.9	2030.02	-191.78	19.03	2774.3	133.4
19.163	17.0	18394.4	2014.22	-224.92	19.01	2715.9	130.9
19.247	11.0	18561.4	1995.68	-230.49	19.00	2651.3	128.1
19.330	.0	18726.8	1976.68	-244.47	19.00	2586.7	125.4
19.830	.0	19685.8	1861.35	-217.63	19.00	2220.9	109.5
20.330	.0	20590.2	1758.32	-195.16	19.00	1922.1	96.2
20.830	.0	21445.8	1665.61	-176.19	19.00	1675.1	85.0
21.330	.0	22257.3	1581.65	-160.04	19.00	1469.0	75.5
21.830	.0	23028.7	1505.18	-146.20	19.00	1295.4	67.3
22.330	.0	23763.5	1435.10	-134.66	19.00	1147.9	60.5
22.830	.0	24464.7	1370.31	-124.71	19.00	1021.2	54.6
23.330	.0	25134.6	1310.22	-115.80	19.00	911.9	49.4
23.830	.0	25775.6	1254.37	-107.74	19.00	817.1	44.6
24.330	.0	26389.6	1202.35	-100.44	19.00	734.5	40.3
24.830	.0	26978.5	1153.80	-93.89	19.00	662.3	36.4
25.330	.0	27543.9	1108.35	-88.02	19.00	598.9	33.0
25.830	.0	28087.3	1065.67	-82.80	19.00	542.9	29.9
26.330	.0	28610.0	1025.46	-78.01	19.00	493.3	27.1
26.830	.0	29113.3	988.29	-70.24	19.00	449.8	22.5
27.330	.0	29599.2	956.28	-59.50	19.00	413.7	16.1
27.830	.0	30070.2	927.86	-54.71	19.00	382.8	13.3
28.330	.0	30527.4	901.25	-51.93	19.00	355.2	11.7
28.830	.0	30971.6	875.79	-50.01	19.00	329.9	10.5
29.330	.0	31403.3	851.17	-48.50	19.00	306.7	9.6
29.830	.0	31822.9	827.24	-47.24	19.00	285.2	8.9
30.330	.0	32230.6	803.91	-46.12	19.00	265.2	8.2
30.830	.0	32626.9	781.10	-45.12	19.00	246.7	7.6
31.330	.0	33011.8	758.78	-44.20	19.00	229.5	7.1
31.830	.0	33385.7	736.89	-43.34	19.00	213.4	6.6
32.330	.0	33748.8	715.42	-42.55	19.00	198.4	6.1
32.830	.0	34101.2	694.33	-41.82	19.00	184.4	5.7
33.330	.0	34443.2	673.60	-41.13	19.00	171.3	5.3
33.830	.0	34774.9	653.19	-40.49	19.00	159.0	4.9
34.330	.0	35096.4	633.10	-39.88	19.00	147.4	4.6
34.830	.0	35408.0	613.31	-39.30	19.00	136.3	4.2
35.330	.0	35709.8	593.79	-38.77	19.00	126.0	3.9
35.830	.0	36001.8	574.53	-38.27	19.00	116.3	3.6
36.330	.0	36284.3	555.52	-37.79	19.00	107.3	3.3
36.830	.0	36557.4	536.73	-37.35	19.00	98.9	3.1
37.330	.0	36821.1	518.16	-36.94	19.00	91.0	2.8
37.830	.0	37075.6	499.79	-36.56	19.00	83.6	2.6
38.330	.0	37320.9	481.60	-36.20	19.00	76.8	2.4
38.830	.0	37557.2	463.59	-35.86	19.00	70.3	2.2
39.330	.0	37784.5	445.74	-35.54	19.00	64.3	2.0
39.830	.0	38003.0	428.04	-35.25	19.00	58.7	1.8
40.330	.0	38212.6	410.48	-34.98	19.00	53.5	1.7
40.830	.0	38413.5	393.06	-34.72	19.00	48.5	1.5
41.330	.0	38605.7	375.76	-34.48	19.00	44.0	1.4
41.830	.0	38789.3	358.58	-34.25	19.00	39.7	1.2
42.330	.0	38964.3	341.51	-34.05	19.00	35.7	1.1
42.830	.0	39130.8	324.53	-33.85	19.00	32.0	1.0
43.330	.0	39288.8	307.65	-33.67	19.00	28.5	.9

43.830	.0	39438.5	290.86	-33.50	19.00	25.3	.8
44.330	.0	39579.7	274.15	-33.35	19.00	22.3	.7
44.830	.0	39712.6	257.51	-33.20	19.00	19.6	.6
45.330	.0	39837.2	240.94	-33.07	19.00	17.0	.5
45.830	.0	39953.6	224.44	-32.95	19.00	14.7	.5
46.330	.0	40061.7	208.00	-32.83	19.00	12.6	.4
46.830	.0	40161.6	191.61	-32.73	19.00	10.6	.3
47.330	.0	40253.3	175.26	-32.64	19.00	8.8	.3
47.830	.0	40336.9	158.97	-32.56	19.00	7.2	.2
48.330	.0	40412.3	142.71	-32.48	19.00	5.8	.2
48.830	.0	40479.6	126.48	-32.41	19.00	4.6	.1
49.330	.0	40538.8	110.29	-32.36	19.00	3.5	.1
49.830	.0	40589.9	94.13	-32.31	19.00	2.5	.1
50.330	.0	40632.9	77.98	-32.27	19.00	1.7	.1
50.830	.0	40667.8	61.86	-32.23	19.00	1.1	.0
51.330	.0	40694.7	45.75	-32.21	19.00	.6	.0
51.830	.0	40713.6	29.65	-32.19	19.00	.2	.0
52.330	.0	40724.4	13.56	-32.18	19.00	.1	.0
52.830	.0	40727.2	-2.53	-32.18	19.00	.0	.0
53.330	.0	40721.9	-18.62	-32.17	19.00	.1	.0
53.830	.0	40708.5	-34.70	-32.16	19.00	.3	.0
54.330	.0	40687.2	-50.77	-32.14	19.00	.7	.0
54.830	.0	40657.8	-66.83	-32.11	19.00	1.3	.0
55.330	.0	40620.3	-82.88	-32.07	19.00	1.9	.1
55.830	.0	40574.9	-98.91	-32.03	19.00	2.8	.1
56.330	.0	40521.4	-114.91	-31.98	19.00	3.8	.1
56.830	.0	40460.0	-130.88	-31.92	19.00	4.9	.2
57.330	.0	40390.6	-146.83	-31.85	19.00	6.2	.2
57.830	.0	40313.2	-162.74	-31.78	19.00	7.6	.2
58.330	.0	40227.8	-178.60	-31.69	19.00	9.2	.3
58.830	.0	40134.6	-194.43	-31.60	19.00	10.9	.3
59.330	.0	40033.4	-210.21	-31.50	19.00	12.9	.4
59.830	.0	39924.4	-225.93	-31.39	19.00	14.9	.5
60.330	.0	39807.5	-241.60	-31.28	19.00	17.2	.5
60.830	.0	39682.8	-257.20	-31.15	19.00	19.6	.6
61.330	.0	39550.3	-272.75	-31.02	19.00	22.1	.7
61.830	.0	39410.1	-288.22	-30.87	19.00	24.9	.8
62.330	.0	39262.1	-303.62	-30.72	19.00	27.8	.9
62.830	.0	39106.4	-318.94	-30.56	19.00	30.9	1.0
63.330	.0	38943.2	-334.17	-30.38	19.00	34.2	1.1
63.830	.0	38772.3	-349.32	-30.20	19.00	37.7	1.2
64.330	.0	38593.9	-364.37	-30.01	19.00	41.4	1.3
64.830	.0	38407.9	-379.32	-29.81	19.00	45.2	1.4
65.330	.0	38214.6	-394.18	-29.59	19.00	49.3	1.5
65.830	.0	38013.8	-408.92	-29.37	19.00	53.5	1.7
66.330	.0	37805.7	-423.54	-29.14	19.00	58.0	1.8
66.830	.0	37590.3	-438.05	-28.89	19.00	62.7	1.9
67.330	.0	37367.6	-452.43	-28.64	19.00	67.6	2.1
67.830	.0	37137.8	-466.69	-28.37	19.00	72.7	2.2
68.330	.0	36901.0	-480.80	-28.09	19.00	78.0	2.4
68.830	.0	36657.1	-494.77	-27.80	19.00	83.6	2.6
69.330	.0	36406.2	-508.59	-27.49	19.00	89.4	2.8
69.830	.0	36148.5	-522.26	-27.18	19.00	95.4	3.0
70.330	.0	35884.0	-535.77	-26.85	19.00	101.7	3.1
70.830	.0	35612.8	-549.11	-26.51	19.00	108.2	3.3
71.330	.0	35334.9	-562.28	-26.15	19.00	115.0	3.6
71.830	.0	35050.5	-575.26	-25.79	19.00	122.0	3.8
72.330	.0	34759.7	-588.06	-25.42	19.00	129.0	4.0
72.830	.0	34462.5	-600.68	-25.06	19.00	136.1	4.2
73.330	.0	34159.0	-613.12	-24.68	19.00	143.4	4.4
73.830	.0	33849.4	-625.36	-24.28	19.00	151.0	4.7
74.330	.0	33533.7	-637.40	-23.88	19.00	158.7	4.9
74.830	.0	33212.0	-649.23	-23.46	19.00	166.7	5.1
75.330	.0	32884.5	-660.85	-23.03	19.00	174.9	5.4

75.830	.0	32551.2	-672.26	-22.59	19.00	183.3	5.7
76.330	.0	32212.3	-683.45	-22.14	19.00	191.8	5.9
76.830	.0	31867.8	-694.40	-21.68	19.00	200.6	6.2
77.330	.0	31517.9	-705.13	-21.21	19.00	209.6	6.5
77.830	.0	31162.7	-715.62	-20.73	19.00	218.7	6.8
78.330	.0	30802.3	-725.86	-20.24	19.00	228.1	7.0
78.830	.0	30436.9	-735.86	-19.74	19.00	237.6	7.3
79.330	.0	30066.5	-745.60	-19.23	19.00	247.2	7.6
79.830	.0	29691.3	-755.09	-18.72	19.00	257.1	7.9
80.330	.0	29311.5	-764.32	-18.19	19.00	267.1	8.3
80.830	.0	28927.1	-773.28	-17.65	19.00	277.3	8.6
81.330	.0	28538.2	-781.97	-17.10	19.00	287.6	8.9
81.830	.0	28145.1	-790.38	-16.55	19.00	298.0	9.2
82.330	.0	27747.9	-798.52	-15.99	19.00	308.6	9.6
82.830	.0	27346.7	-806.37	-15.42	19.00	319.2	9.9
83.330	.0	26941.6	-813.93	-14.84	19.00	330.0	10.2
83.830	.0	26532.8	-821.21	-14.26	19.00	340.9	10.6
84.330	.0	26120.4	-828.19	-13.66	19.00	351.8	10.9
84.830	.0	25704.7	-834.87	-13.07	19.00	362.9	11.3
85.330	.0	25285.6	-841.25	-12.47	19.00	373.9	11.6
85.830	.0	24863.4	-847.34	-11.86	19.00	385.0	12.0
86.330	.0	24438.3	-853.11	-11.25	19.00	396.2	12.4
86.830	.0	24010.4	-858.59	-10.64	19.00	407.3	12.7
87.330	.0	23579.8	-863.75	-10.03	19.00	418.5	13.1
87.830	.0	23146.7	-868.61	-9.41	19.00	429.6	13.4
88.330	.0	22711.2	-873.17	-8.80	19.00	440.8	13.8
88.830	.0	22273.6	-877.41	-8.19	19.00	451.8	14.2
89.330	.0	21833.9	-881.36	-7.58	19.00	462.8	14.5
89.830	.0	21392.3	-885.00	-6.98	19.00	473.8	14.9
90.330	.0	20948.9	-888.34	-6.38	19.00	484.7	15.2
90.830	.0	20504.0	-891.38	-5.79	19.00	495.4	15.6
91.330	.0	20057.6	-894.13	-5.21	19.00	506.1	15.9
91.830	.0	19609.9	-896.59	-4.64	19.00	516.6	16.3
92.330	.0	19161.0	-898.77	-4.07	19.00	527.0	16.6
92.830	.0	18711.2	-900.66	-3.52	19.00	537.3	16.9
93.330	.0	18260.4	-902.29	-2.98	19.00	547.4	17.2
93.830	.0	17808.9	-903.65	-2.45	19.00	557.4	17.6
94.330	.0	17356.8	-904.74	-1.94	19.00	567.2	17.9
94.830	.0	16904.2	-905.59	-1.43	19.00	576.8	18.2
95.330	.0	16451.3	-906.18	-.95	19.00	586.3	18.4
95.830	.0	15998.1	-906.53	-.47	19.00	595.5	18.7
96.330	.0	15544.8	-906.65	-.01	19.00	604.6	19.0
96.830	.0	15091.5	-906.55	.44	19.00	613.5	19.3
97.330	.0	14638.3	-906.22	.87	19.00	622.1	19.5
97.830	.0	14185.3	-905.67	1.30	19.00	630.5	19.8
98.330	.0	13732.6	-904.92	1.70	19.00	638.8	20.0
98.830	.0	13280.4	-903.97	2.10	19.00	646.8	20.2
99.330	.0	12828.7	-902.83	2.48	19.00	654.5	20.5
99.830	.0	12377.6	-901.49	2.85	19.00	662.1	20.7
100.330	.0	11927.2	-899.98	3.21	19.00	669.4	20.9
100.830	.0	11477.7	-898.28	3.55	19.00	676.4	21.1
101.330	.0	11029.0	-896.42	3.89	19.00	683.3	21.3
101.830	.0	10581.3	-894.40	4.21	19.00	689.8	21.5
102.330	.0	10134.6	-892.22	4.51	19.00	696.2	21.7
102.830	.0	9689.1	-889.89	4.81	19.00	702.3	21.8
103.330	.0	9244.7	-887.41	5.09	19.00	708.1	22.0
103.830	.0	8801.7	-884.79	5.37	19.00	713.7	22.2
104.330	.0	8360.0	-882.05	5.63	19.00	719.1	22.3
104.830	.0	7919.7	-879.17	5.88	19.00	724.2	22.5
105.330	.0	7480.8	-876.17	6.11	19.00	729.0	22.6
105.830	.0	7043.5	-873.06	6.34	19.00	733.7	22.7
106.330	.0	6607.8	-869.84	6.55	19.00	738.0	22.9
106.830	.0	6173.7	-866.51	6.75	19.00	742.2	23.0
107.330	.0	5741.3	-863.09	6.94	19.00	746.1	23.1

107.830	.0	5310.6	-859.57	7.12	19.00	749.7	23.2
108.330	.0	4881.7	-855.96	7.29	19.00	753.1	23.3
108.830	.0	4454.7	-852.28	7.45	19.00	756.3	23.4
109.330	.0	4029.5	-848.51	7.60	19.00	759.3	23.5
109.830	.0	3606.2	-844.68	7.73	19.00	762.1	23.6
110.330	.0	3184.8	-840.78	7.86	19.00	764.6	23.6
110.830	.0	2765.4	-836.82	7.98	19.00	767.0	23.7
111.330	.0	2348.0	-832.81	8.08	19.00	769.1	23.8
111.830	.0	1932.6	-828.74	8.18	19.00	771.0	23.8
112.330	.0	1519.2	-824.63	8.26	19.00	772.8	23.9
112.830	.0	1108.0	-820.48	8.34	19.00	774.3	23.9
113.330	.0	698.8	-816.29	8.41	19.00	775.7	24.0
113.830	.0	291.7	-812.08	8.47	19.00	776.9	24.0
114.330	.0	-113.3	-807.83	8.52	19.00	778.0	24.0

Maximum altitude: 40727.2 feet

Maximum velocity: 2049.12 feet/sec.

Maximum acceleration: 646.20 feet/sec<sup>2</sup>

Minimum acceleration: -244.471 feet/sec<sup>2</sup>

Maximum Mach number : 1.96 at 18.91 sec.

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ECHO OF INPUT DATA:

FILE, RCON700.DAT  
 TITLE, MiniSShot Flight  
 UNITS, ENGLISH  
 STAGES, 2  
 Cd:, Standard for sharp nose rocket  
 STAGE1 MASS, .3830  
 STAGE2 MASS, 19.0000  
 STAGE1 DIA., 3.5500  
 STAGE2 DIA., 3.5500  
 SEP1 q, 240.0000

FILE, THR700.DAT  
 TITLE, ProtoSShot III 1st Phase data  
 UNITS, ENGLISH  
 Pmass, 11.53800  
 TIME STEP, .08333  
 DATA POINTS, 48  
 PRINTALL?, Yes  
 THRUST VALUE, 1, .0000  
 THRUST VALUE, 2, 56.0000  
 THRUST VALUE, 3, 60.0000  
 THRUST VALUE, 4, 234.0000  
 THRUST VALUE, 5, 426.0000  
 THRUST VALUE, 6, 536.0000  
 THRUST VALUE, 7, 488.0000  
 THRUST VALUE, 8, 472.0000  
 THRUST VALUE, 9, 477.0000  
 THRUST VALUE, 10, 473.0000  
 THRUST VALUE, 11, 465.0000  
 THRUST VALUE, 12, 466.0000  
 THRUST VALUE, 13, 468.0000  
 THRUST VALUE, 14, 480.0000  
 THRUST VALUE, 15, 478.0000  
 THRUST VALUE, 16, 483.0000  
 THRUST VALUE, 17, 477.0000

THRUST VALUE,	18,	493.0000
THRUST VALUE,	19,	489.0000
THRUST VALUE,	20,	488.0000
THRUST VALUE,	21,	488.0000
THRUST VALUE,	22,	488.0000
THRUST VALUE,	23,	481.0000
THRUST VALUE,	24,	483.0000
THRUST VALUE,	25,	485.0000
THRUST VALUE,	26,	480.0000
THRUST VALUE,	27,	478.0000
THRUST VALUE,	28,	476.0000
THRUST VALUE,	29,	469.0000
THRUST VALUE,	30,	477.0000
THRUST VALUE,	31,	469.0000
THRUST VALUE,	32,	456.0000
THRUST VALUE,	33,	454.0000
THRUST VALUE,	34,	443.0000
THRUST VALUE,	35,	437.0000
THRUST VALUE,	36,	418.0000
THRUST VALUE,	37,	416.0000
THRUST VALUE,	38,	395.0000
THRUST VALUE,	39,	383.0000
THRUST VALUE,	40,	372.0000
THRUST VALUE,	41,	335.0000
THRUST VALUE,	42,	266.0000
THRUST VALUE,	43,	210.0000
THRUST VALUE,	44,	151.0000
THRUST VALUE,	45,	102.0000
THRUST VALUE,	46,	57.0000
THRUST VALUE,	47,	32.0000
THRUST VALUE,	48,	.0000

FILE,	THR701.DAT	
TITLE,	ProtoSShot III Phase 2 data	
UNITS,	ENGLISH	
Pmass,	11.576000	
TIME STEP,	.08333	
DATA POINTS,	54	
PRINTALL?,	Yes	
THRUST VALUE,	1,	.0000
THRUST VALUE,	2,	24.0000
THRUST VALUE,	3,	22.0000
THRUST VALUE,	4,	20.0000
THRUST VALUE,	5,	30.0000
THRUST VALUE,	6,	108.0000
THRUST VALUE,	7,	192.0000
THRUST VALUE,	8,	332.0000
THRUST VALUE,	9,	467.0000
THRUST VALUE,	10,	528.0000
THRUST VALUE,	11,	568.0000
THRUST VALUE,	12,	586.0000
THRUST VALUE,	13,	598.0000
THRUST VALUE,	14,	612.0000
THRUST VALUE,	15,	606.0000
THRUST VALUE,	16,	589.0000
THRUST VALUE,	17,	593.0000
THRUST VALUE,	18,	582.0000
THRUST VALUE,	19,	594.0000
THRUST VALUE,	20,	577.0000
THRUST VALUE,	21,	569.0000
THRUST VALUE,	22,	554.0000
THRUST VALUE,	23,	552.0000
THRUST VALUE,	24,	541.0000
THRUST VALUE,	25,	529.0000

THRUST VALUE,	26,	518.0000
THRUST VALUE,	27,	501.0000
THRUST VALUE,	28,	485.0000
THRUST VALUE,	29,	470.0000
THRUST VALUE,	30,	456.0000
THRUST VALUE,	31,	449.0000
THRUST VALUE,	32,	431.0000
THRUST VALUE,	33,	426.0000
THRUST VALUE,	34,	416.0000
THRUST VALUE,	35,	407.0000
THRUST VALUE,	36,	393.0000
THRUST VALUE,	37,	380.0000
THRUST VALUE,	38,	364.0000
THRUST VALUE,	39,	349.0000
THRUST VALUE,	40,	331.0000
THRUST VALUE,	41,	322.0000
THRUST VALUE,	42,	300.0000
THRUST VALUE,	43,	289.0000
THRUST VALUE,	44,	273.0000
THRUST VALUE,	45,	256.0000
THRUST VALUE,	46,	242.0000
THRUST VALUE,	47,	203.0000
THRUST VALUE,	48,	158.0000
THRUST VALUE,	49,	107.0000
THRUST VALUE,	50,	66.0000
THRUST VALUE,	51,	39.0000
THRUST VALUE,	52,	17.0000
THRUST VALUE,	53,	11.0000
THRUST VALUE,	54,	.0000

\*\*\*\*\* END OF PRINTOUT \*\*\*\*\*

**Appendix B**  
**SOAR Output, AeroLab Cd, US customary units**

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SOAR Output File: SOAR702.OUT                               Opt:1
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Stage 1  Computed Propellant Specific Impulse =           131.5  lb-sec/lb
Stage 1  Computed Engine Total Impulse =                 1516.9  lb-sec
Stage 2  Computed Propellant Specific Impulse =           136.9  lb-sec/lb
Stage 2  Computed Engine Total Impulse =                 1585.4  lb-sec

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Stage 1:

Time sec.	Thrust lb.	Altitude feet	Velocity ft/sec.	Acceleration ft/sec2	Mass lb.	Dyn.Press. lb/ft2	Drag lb.
.000	.0	1653.3	.00	-32.18	42.50	293.3	.0
.083	56.0	1653.2	-2.68	10.24	42.48	.0	.0
.167	60.0	1653.0	-1.83	13.31	42.44	.0	.0
.250	234.0	1652.9	-.72	145.61	42.35	.0	.0
.333	426.0	1653.4	11.41	293.08	42.14	.1	.0
.417	536.0	1655.4	35.82	380.00	41.84	1.5	.1
.500	488.0	1659.7	67.47	345.90	41.51	5.2	.2
.583	472.0	1666.5	96.28	336.01	41.21	10.5	.5
.666	477.0	1675.7	124.26	342.42	40.91	17.5	.8
.750	473.0	1687.2	152.77	341.72	40.61	26.4	1.1
.833	465.0	1701.1	181.22	337.73	40.31	37.1	1.6
.916	466.0	1717.4	209.34	340.83	40.01	49.5	2.1
1.000	468.0	1736.0	237.71	344.74	39.72	63.8	2.7
1.083	480.0	1757.0	266.40	356.84	39.42	80.1	3.4
1.166	478.0	1780.4	296.10	357.55	39.11	98.9	4.2
1.250	483.0	1806.3	325.85	364.03	38.81	119.6	5.1
1.333	477.0	1834.7	356.14	361.32	38.51	142.8	6.1
1.416	493.0	1865.7	386.21	377.08	38.20	167.8	7.1
1.499	489.0	1899.1	417.57	376.03	37.89	195.9	8.3
1.583	488.0	1935.2	448.85	377.45	37.58	226.2	9.6
1.666	488.0	1973.9	480.25	379.68	37.27	258.6	11.0
1.749	488.0	2015.2	511.82	381.86	36.96	293.4	12.4
1.833	481.0	2059.2	543.58	377.82	36.65	330.5	14.0
1.916	483.0	2105.8	574.99	381.60	36.35	369.3	15.6
1.999	485.0	2155.0	606.71	385.38	36.04	410.5	17.3
2.082	480.0	2206.9	638.75	382.81	35.73	454.3	19.1
2.166	478.0	2261.4	670.57	382.84	35.43	499.9	21.0
2.249	476.0	2318.6	702.38	382.78	35.13	547.5	23.0
2.332	469.0	2378.4	734.19	377.99	34.83	597.2	25.0
2.416	477.0	2440.9	765.60	387.05	34.53	648.2	27.1
2.499	469.0	2506.0	797.76	381.20	34.23	702.4	29.2
2.582	456.0	2573.8	829.43	370.43	33.94	757.8	31.3
2.666	454.0	2644.2	860.20	369.96	33.65	813.3	33.4
2.749	443.0	2717.1	890.93	360.71	33.36	870.6	35.6
2.832	437.0	2792.6	920.90	356.12	33.09	928.1	37.7
2.916	418.0	2870.5	950.47	338.60	32.81	986.4	39.9
2.999	416.0	2950.8	978.60	337.59	32.55	1043.1	41.9
3.082	395.0	3033.5	1006.63	317.54	32.29	1101.0	44.0
3.165	383.0	3118.5	1033.00	306.20	32.05	1156.5	46.0
3.249	372.0	3205.6	1058.43	295.67	31.81	1211.0	47.9
3.332	335.0	3294.8	1082.98	258.40	31.58	1264.4	49.8
3.415	266.0	3385.9	1104.43	187.78	31.39	1311.5	51.4
3.499	210.0	3478.5	1119.79	124.05	31.24	1344.5	58.3
3.582	151.0	3572.2	1129.91	58.57	31.13	1365.0	63.2
3.665	102.0	3666.6	1134.69	5.60	31.05	1372.7	65.5
3.749	57.0	3761.1	1135.15	-41.24	31.00	1370.0	65.7
3.832	32.0	3855.5	1131.79	-65.45	30.97	1358.0	64.0
3.915	.0	3949.6	1126.45	-95.97	30.96	1341.4	61.4

4.415	.0	4501.7	1083.30	-82.04	30.96	1220.2	48.0
4.915	.0	5033.3	1043.30	-78.03	30.96	1113.8	44.1
5.415	.0	5545.3	1005.20	-74.40	30.96	1018.0	40.6
5.915	.0	6038.8	968.85	-71.08	30.96	931.6	37.4
6.415	.0	6514.4	934.08	-68.05	30.96	853.5	34.5
6.915	.0	6973.1	900.75	-65.28	30.96	782.6	31.9
7.415	.0	7415.4	868.76	-62.74	30.96	718.2	29.4
7.915	.0	7842.1	837.98	-60.40	30.96	659.5	27.2
8.415	.0	8253.6	808.33	-58.25	30.96	605.9	25.1
8.915	.0	8650.6	779.71	-56.27	30.96	556.9	23.2
9.415	.0	9033.5	752.04	-54.42	30.96	511.9	21.4
9.915	.0	9402.7	725.28	-52.65	30.96	470.7	19.7
10.415	.0	9758.9	699.37	-51.02	30.96	432.8	18.1
10.915	.0	10102.2	674.24	-49.53	30.96	398.0	16.7
11.415	.0	10433.2	649.82	-48.14	30.96	365.8	15.4
11.915	.0	10752.2	626.07	-46.87	30.96	336.2	14.1
12.415	.0	11059.4	602.94	-45.68	30.96	308.8	13.0
12.915	.0	11355.2	580.37	-44.59	30.96	283.5	11.9
13.415	.0	11639.9	558.34	-43.57	30.96	260.0	11.0
13.915	.0	11913.6	536.79	-42.63	30.96	238.2	10.1
14.415	.0	12176.7	515.70	-41.75	30.96	218.0	9.2
14.915	.0	12429.4	495.03	-40.94	30.96	199.3	8.4

Stage 2:

Time sec.	Thrust lb.	Altitude feet	Velocity ft/sec.	Acceleration ft/sec2	Mass lb.	Dyn.Press. lb/ft2	Drag lb.
14.915	.0	12429.4	495.03	-41.05	30.58	180.0	8.4
14.998	24.0	12470.5	491.61	-15.66	30.57	196.3	8.3
15.082	22.0	12511.4	490.31	-17.70	30.55	195.0	8.3
15.165	20.0	12552.2	488.84	-19.74	30.54	193.6	8.2
15.248	30.0	12592.8	487.20	-9.12	30.53	192.0	8.1
15.332	108.0	12633.4	486.44	73.27	30.48	191.2	8.1
15.415	192.0	12674.2	492.54	162.31	30.39	195.8	8.3
15.498	332.0	12715.7	506.04	311.85	30.23	206.4	8.7
15.582	467.0	12759.0	531.97	458.51	29.99	227.8	9.6
15.665	528.0	12804.9	570.11	528.11	29.69	261.2	11.0
15.748	568.0	12854.2	614.02	576.44	29.36	302.5	12.7
15.831	586.0	12907.3	661.95	601.55	29.00	351.0	14.7
15.915	598.0	12964.6	711.96	620.48	28.64	405.3	17.0
15.998	612.0	13026.0	763.53	642.16	28.28	465.2	19.4
16.081	606.0	13091.9	816.90	641.28	27.91	531.4	21.9
16.165	589.0	13162.1	870.19	627.23	27.54	601.6	24.5
16.248	593.0	13236.8	922.31	637.52	27.18	674.2	27.2
16.331	582.0	13315.8	975.28	629.88	26.83	752.0	30.0
16.414	594.0	13399.2	1027.61	649.94	26.47	832.6	32.9
16.498	577.0	13487.1	1081.52	629.01	26.11	919.6	40.4
16.581	569.0	13579.3	1132.96	604.30	25.76	1006.2	59.4
16.664	554.0	13675.8	1182.91	586.01	25.42	1093.5	65.6
16.748	552.0	13776.4	1231.50	586.45	25.09	1181.3	69.7
16.831	541.0	13881.0	1280.13	575.10	24.75	1272.2	73.8
16.914	529.0	13989.6	1327.82	562.09	24.43	1363.9	77.8
16.998	518.0	14102.1	1374.43	550.06	24.11	1456.1	81.7
17.081	501.0	14218.5	1420.04	529.57	23.80	1548.5	85.5
17.164	485.0	14338.7	1463.95	509.94	23.50	1639.3	89.1
17.247	470.0	14462.4	1506.24	491.27	23.21	1728.5	92.4
17.331	456.0	14589.5	1546.97	473.60	22.93	1815.7	95.6
17.414	449.0	14720.0	1586.25	465.57	22.65	1901.0	98.6
17.497	431.0	14853.8	1624.86	441.55	22.38	1986.1	101.4
17.581	426.0	14990.7	1661.49	436.06	22.12	2067.4	104.0
17.664	416.0	15130.6	1697.66	423.15	21.87	2148.6	106.5
17.747	407.0	15273.5	1732.76	411.55	21.62	2228.0	108.9
17.831	393.0	15419.2	1766.91	392.24	21.37	2305.6	111.1
17.914	380.0	15567.8	1799.46	374.16	21.14	2379.8	113.0
17.997	364.0	15719.0	1830.51	351.18	20.91	2450.5	114.8

18.080	349.0	15872.6	1859.66	329.44	20.70	2516.5	116.4
18.164	331.0	16028.7	1887.01	302.66	20.49	2577.8	117.8
18.247	322.0	16186.9	1912.15	289.85	20.29	2633.3	118.9
18.330	300.0	16347.2	1936.23	256.04	20.10	2685.8	119.9
18.414	289.0	16509.4	1957.50	239.62	19.92	2730.6	120.7
18.497	273.0	16673.3	1977.42	214.88	19.75	2771.4	121.3
18.580	256.0	16838.7	1995.29	188.24	19.59	2806.4	121.8
18.664	242.0	17005.6	2010.95	166.33	19.44	2834.9	122.1
18.747	203.0	17173.7	2024.80	102.50	19.30	2858.2	122.2
18.830	158.0	17342.7	2033.35	28.21	19.19	2866.3	122.0
18.913	107.0	17512.2	2035.74	-56.36	19.11	2857.0	121.4
18.997	66.0	17681.6	2031.12	-123.87	19.06	2828.1	120.3
19.080	39.0	17850.3	2020.90	-167.35	19.03	2784.0	118.9
19.163	17.0	18018.1	2007.07	-202.02	19.01	2730.8	117.4
19.247	11.0	18184.6	1990.37	-209.28	19.00	2670.6	115.6
19.330	.0	18349.7	1973.06	-224.92	19.00	2610.0	113.8
19.830	.0	19308.9	1865.21	-206.74	19.00	2258.7	103.1
20.330	.0	20216.3	1766.05	-190.19	19.00	1963.8	93.3
20.830	.0	21076.2	1674.76	-175.22	19.00	1715.1	84.5
21.330	.0	21892.3	1590.58	-161.75	19.00	1504.4	76.5
21.830	.0	22667.9	1512.78	-149.64	19.00	1325.0	69.4
22.330	.0	23406.0	1440.73	-138.78	19.00	1171.4	63.0
22.830	.0	24109.4	1373.82	-129.04	19.00	1039.3	57.2
23.330	.0	24780.6	1311.53	-120.29	19.00	925.2	52.0
23.830	.0	25421.7	1253.38	-112.44	19.00	826.1	47.4
24.330	.0	26034.6	1198.96	-105.38	19.00	739.6	43.2
24.830	.0	26621.2	1147.89	-99.01	19.00	664.0	39.5
25.330	.0	27183.0	1099.84	-93.27	19.00	597.4	36.1
25.830	.0	27721.5	1055.14	-81.76	19.00	539.3	29.3
26.330	.0	28239.4	1017.77	-68.45	19.00	492.5	21.4
26.830	.0	28740.2	985.69	-62.38	19.00	453.6	17.8
27.330	.0	29225.3	955.05	-60.21	19.00	418.4	16.6
27.830	.0	29695.4	925.45	-58.21	19.00	386.1	15.4
28.330	.0	30150.9	896.82	-56.36	19.00	356.6	14.3
28.830	.0	30592.4	869.08	-54.64	19.00	329.5	13.3
29.330	.0	31020.1	842.16	-53.06	19.00	304.5	12.3
29.830	.0	31434.7	816.00	-51.58	19.00	281.5	11.5
30.330	.0	31836.3	790.56	-50.21	19.00	260.3	10.7
30.830	.0	32225.3	765.77	-48.94	19.00	240.7	9.9
31.330	.0	32602.1	741.60	-47.75	19.00	222.6	9.2
31.830	.0	32967.0	718.00	-46.65	19.00	205.8	8.5
32.330	.0	33320.2	694.94	-45.62	19.00	190.2	7.9
32.830	.0	33662.0	672.38	-44.63	19.00	175.8	7.4
33.330	.0	33992.7	650.30	-43.69	19.00	162.4	6.8
33.830	.0	34312.4	628.68	-42.82	19.00	149.9	6.3
34.330	.0	34621.4	607.48	-42.01	19.00	138.3	5.8
34.830	.0	34920.0	586.67	-41.25	19.00	127.6	5.4
35.330	.0	35208.2	566.22	-40.53	19.00	117.3	4.9
35.830	.0	35486.2	546.13	-39.85	19.00	107.7	4.5
36.330	.0	35754.4	526.36	-39.22	19.00	98.8	4.2
36.830	.0	36012.7	506.90	-38.64	19.00	90.5	3.8
37.330	.0	36261.3	487.72	-38.09	19.00	82.8	3.5
37.830	.0	36500.4	468.80	-37.59	19.00	75.6	3.2
38.330	.0	36730.1	450.13	-37.12	19.00	69.0	2.9
38.830	.0	36950.6	431.68	-36.68	19.00	62.8	2.7
39.330	.0	37161.9	413.45	-36.27	19.00	57.0	2.4
39.830	.0	37364.1	395.41	-35.89	19.00	51.6	2.2
40.330	.0	37557.3	377.56	-35.53	19.00	46.6	2.0
40.830	.0	37741.6	359.87	-35.20	19.00	42.0	1.8
41.330	.0	37917.2	342.35	-34.89	19.00	37.7	1.6
41.830	.0	38084.0	324.98	-34.61	19.00	33.7	1.4
42.330	.0	38242.2	307.74	-34.34	19.00	30.0	1.3
42.830	.0	38391.8	290.63	-34.09	19.00	26.6	1.1
43.330	.0	38532.9	273.65	-33.87	19.00	23.4	1.0

43.830	.0	38665.4	256.76	-33.66	19.00	20.5	.9
44.330	.0	38789.6	239.99	-33.46	19.00	17.8	.8
44.830	.0	38905.5	223.30	-33.29	19.00	15.3	.7
45.330	.0	39012.9	206.70	-33.12	19.00	13.0	.6
45.830	.0	39112.2	190.17	-32.97	19.00	11.0	.5
46.330	.0	39203.1	173.72	-32.84	19.00	9.1	.4
46.830	.0	39285.9	157.33	-32.72	19.00	7.5	.3
47.330	.0	39360.5	141.00	-32.61	19.00	6.0	.3
47.830	.0	39426.9	124.72	-32.52	19.00	4.7	.2
48.330	.0	39485.2	108.48	-32.43	19.00	3.5	.2
48.830	.0	39535.4	92.29	-32.36	19.00	2.5	.1
49.330	.0	39577.5	76.12	-32.30	19.00	1.7	.1
49.830	.0	39611.5	59.98	-32.25	19.00	1.1	.0
50.330	.0	39637.5	43.87	-32.22	19.00	.6	.0
50.830	.0	39655.4	27.76	-32.19	19.00	.2	.0
51.330	.0	39665.3	11.67	-32.18	19.00	.0	.0
51.830	.0	39667.1	-4.42	-32.18	19.00	.0	.0
52.330	.0	39660.8	-20.50	-32.17	19.00	.1	.0
52.830	.0	39646.6	-36.58	-32.15	19.00	.4	.0
53.330	.0	39624.3	-52.65	-32.12	19.00	.8	.0
53.830	.0	39593.9	-68.69	-32.07	19.00	1.4	.1
54.330	.0	39555.6	-84.72	-32.02	19.00	2.1	.1
54.830	.0	39509.2	-100.71	-31.95	19.00	3.0	.1
55.330	.0	39454.9	-116.67	-31.88	19.00	4.1	.2
55.830	.0	39392.5	-132.59	-31.79	19.00	5.3	.2
56.330	.0	39322.3	-148.46	-31.69	19.00	6.6	.3
56.830	.0	39244.1	-164.28	-31.58	19.00	8.2	.4
57.330	.0	39158.0	-180.04	-31.46	19.00	9.8	.4
57.830	.0	39064.1	-195.74	-31.33	19.00	11.7	.5
58.330	.0	38962.3	-211.37	-31.18	19.00	13.7	.6
58.830	.0	38852.7	-226.92	-31.03	19.00	15.8	.7
59.330	.0	38735.4	-242.39	-30.86	19.00	18.2	.8
59.830	.0	38610.3	-257.78	-30.68	19.00	20.7	.9
60.330	.0	38477.6	-273.07	-30.49	19.00	23.4	1.0
60.830	.0	38337.3	-288.26	-30.28	19.00	26.2	1.1
61.330	.0	38189.4	-303.35	-30.07	19.00	29.2	1.2
61.830	.0	38033.9	-318.33	-29.84	19.00	32.4	1.4
62.330	.0	37871.1	-333.19	-29.60	19.00	35.8	1.5
62.830	.0	37700.8	-347.92	-29.34	19.00	39.3	1.7
63.330	.0	37523.2	-362.53	-29.08	19.00	43.1	1.8
63.830	.0	37338.3	-376.99	-28.80	19.00	47.0	2.0
64.330	.0	37146.2	-391.32	-28.50	19.00	51.1	2.2
64.830	.0	36947.0	-405.50	-28.20	19.00	55.4	2.3
65.330	.0	36740.7	-419.52	-27.88	19.00	59.9	2.5
65.830	.0	36527.5	-433.37	-27.55	19.00	64.5	2.7
66.330	.0	36307.4	-447.06	-27.20	19.00	69.4	2.9
66.830	.0	36080.4	-460.57	-26.84	19.00	74.5	3.1
67.330	.0	35846.8	-473.90	-26.47	19.00	79.7	3.4
67.830	.0	35606.6	-487.05	-26.09	19.00	85.2	3.6
68.330	.0	35359.8	-499.99	-25.69	19.00	90.8	3.8
68.830	.0	35106.6	-512.73	-25.28	19.00	96.6	4.1
69.330	.0	34847.1	-525.26	-24.86	19.00	102.5	4.3
69.830	.0	34581.4	-537.59	-24.44	19.00	108.5	4.6
70.330	.0	34309.6	-549.70	-24.01	19.00	114.6	4.8
70.830	.0	34031.7	-561.59	-23.56	19.00	120.9	5.1
71.330	.0	33748.0	-573.26	-23.11	19.00	127.4	5.4
71.830	.0	33458.5	-584.70	-22.64	19.00	134.0	5.6
72.330	.0	33163.3	-595.90	-22.17	19.00	140.7	5.9
72.830	.0	32862.6	-606.87	-21.69	19.00	147.6	6.2
73.330	.0	32556.5	-617.59	-21.19	19.00	154.6	6.5
73.830	.0	32245.1	-628.06	-20.69	19.00	161.8	6.8
74.330	.0	31928.5	-638.27	-20.18	19.00	169.1	7.1
74.830	.0	31606.9	-648.23	-19.65	19.00	176.5	7.4
75.330	.0	31280.3	-657.92	-19.13	19.00	184.1	7.7

75.830	.0	30949.0	-667.35	-18.59	19.00	191.7	8.0
76.330	.0	30613.0	-676.51	-18.04	19.00	199.5	8.3
76.830	.0	30272.5	-685.40	-17.49	19.00	207.4	8.7
77.330	.0	29927.7	-694.00	-16.94	19.00	215.3	9.0
77.830	.0	29578.6	-702.33	-16.38	19.00	223.3	9.3
78.330	.0	29225.4	-710.39	-15.83	19.00	231.5	9.7
78.830	.0	28868.2	-718.16	-15.28	19.00	239.7	10.0
79.330	.0	28507.3	-725.66	-14.72	19.00	247.9	10.3
79.830	.0	28142.6	-732.88	-14.15	19.00	256.2	10.6
80.330	.0	27774.4	-739.81	-13.59	19.00	264.6	11.0
80.830	.0	27402.8	-746.47	-13.02	19.00	273.0	11.3
81.330	.0	27028.0	-752.83	-12.45	19.00	281.5	11.6
81.830	.0	26650.1	-758.91	-11.88	19.00	289.9	12.0
82.330	.0	26269.1	-764.71	-11.30	19.00	298.4	12.3
82.830	.0	25885.4	-770.22	-10.73	19.00	306.9	12.7
83.330	.0	25499.0	-775.44	-10.16	19.00	315.3	13.0
83.830	.0	25110.0	-780.37	-9.58	19.00	323.8	13.3
84.330	.0	24718.6	-785.02	-9.01	19.00	332.2	13.7
84.830	.0	24325.0	-789.39	-8.44	19.00	340.6	14.0
85.330	.0	23929.3	-793.47	-7.88	19.00	348.9	14.3
85.830	.0	23531.6	-797.27	-7.32	19.00	357.2	14.7
86.330	.0	23132.1	-800.78	-6.76	19.00	365.3	15.0
86.830	.0	22730.9	-804.02	-6.20	19.00	373.5	15.3
87.330	.0	22328.1	-806.99	-5.65	19.00	381.5	15.7
87.830	.0	21923.9	-809.68	-5.11	19.00	389.4	16.0
88.330	.0	21518.5	-812.10	-4.57	19.00	397.2	16.3
88.830	.0	21111.9	-814.25	-4.04	19.00	404.9	16.6
89.330	.0	20704.3	-816.14	-3.52	19.00	412.5	16.9
89.830	.0	20295.8	-817.77	-3.00	19.00	419.9	17.2
90.330	.0	19886.5	-819.15	-2.50	19.00	427.2	17.5
90.830	.0	19476.7	-820.27	-2.00	19.00	434.4	17.8
91.330	.0	19066.3	-821.15	-1.51	19.00	441.3	18.1
91.830	.0	18655.6	-821.79	-1.04	19.00	448.2	18.4
92.330	.0	18244.6	-822.19	-.57	19.00	454.8	18.7
92.830	.0	17833.4	-822.36	-.11	19.00	461.3	18.9
93.330	.0	17422.2	-822.30	.33	19.00	467.5	19.2
93.830	.0	17011.2	-822.03	.77	19.00	473.6	19.5
94.330	.0	16600.3	-821.54	1.19	19.00	479.5	19.7
94.830	.0	16189.7	-820.84	1.60	19.00	485.2	19.9
95.330	.0	15779.5	-819.94	2.00	19.00	490.7	20.2
95.830	.0	15369.7	-818.84	2.38	19.00	496.0	20.4
96.330	.0	14960.6	-817.56	2.75	19.00	501.1	20.6
96.830	.0	14552.2	-816.09	3.11	19.00	505.9	20.8
97.330	.0	14144.6	-814.45	3.46	19.00	510.6	21.0
97.830	.0	13737.8	-812.64	3.79	19.00	515.0	21.2
98.330	.0	13332.0	-810.66	4.11	19.00	519.3	21.4
98.830	.0	12927.2	-808.53	4.41	19.00	523.3	21.6
99.330	.0	12523.5	-806.25	4.71	19.00	527.1	21.8
99.830	.0	12120.9	-803.83	4.98	19.00	530.7	21.9
100.330	.0	11719.6	-801.27	5.25	19.00	534.1	22.1
100.830	.0	11319.7	-798.58	5.50	19.00	537.3	22.2
101.330	.0	10921.1	-795.77	5.74	19.00	540.3	22.4
101.830	.0	10523.9	-792.84	5.97	19.00	543.1	22.5
102.330	.0	10128.3	-789.81	6.18	19.00	545.6	22.6
102.830	.0	9734.1	-786.67	6.38	19.00	548.0	22.8
103.330	.0	9341.6	-783.43	6.57	19.00	550.2	22.9
103.830	.0	8950.7	-780.10	6.74	19.00	552.3	23.0
104.330	.0	8561.5	-776.69	6.91	19.00	554.1	23.1
104.830	.0	8174.1	-773.20	7.06	19.00	555.7	23.2
105.330	.0	7788.3	-769.63	7.20	19.00	557.2	23.3
105.830	.0	7404.4	-766.00	7.33	19.00	558.5	23.3
106.330	.0	7022.4	-762.31	7.44	19.00	559.7	23.4
106.830	.0	6642.1	-758.57	7.52	19.00	560.7	23.4
107.330	.0	6263.8	-754.79	7.59	19.00	561.6	23.5

107.830	.0	5887.3	-750.98	7.65	19.00	562.3	23.5
108.330	.0	5512.8	-747.15	7.70	19.00	563.0	23.5
108.830	.0	5140.2	-743.28	7.75	19.00	563.5	23.6
109.330	.0	4769.5	-739.40	7.79	19.00	563.9	23.6
109.830	.0	4400.8	-735.50	7.82	19.00	564.2	23.6
110.330	.0	4034.0	-731.58	7.84	19.00	564.4	23.6
110.830	.0	3669.2	-727.66	7.86	19.00	564.5	23.6
111.330	.0	3306.4	-723.73	7.87	19.00	564.5	23.6
111.830	.0	2945.5	-719.79	7.87	19.00	564.4	23.6
112.330	.0	2586.6	-715.86	7.87	19.00	564.2	23.6
112.830	.0	2229.6	-711.93	7.86	19.00	564.0	23.6
113.330	.0	1874.7	-708.00	7.85	19.00	563.7	23.6
113.830	.0	1521.6	-704.08	7.83	19.00	563.3	23.6
114.330	.0	1170.6	-700.17	7.80	19.00	562.9	23.6
114.830	.0	821.5	-696.28	7.78	19.00	562.4	23.6
115.330	.0	474.3	-692.40	7.75	19.00	561.8	23.6
115.830	.0	129.1	-688.53	7.71	19.00	561.2	23.6
116.330	.0	-214.2	-684.69	7.67	19.00	560.5	23.5

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Maximum altitude: 39667.1 feet

Maximum velocity: 2035.74 feet/sec.

Maximum acceleration: 649.94 feet/sec<sup>2</sup>

Minimum acceleration: -224.918 feet/sec<sup>2</sup>

Maximum Mach number : 1.94 at 18.91 sec.

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ECHO OF INPUT DATA:

FILE, RCON702.DAT  
 TITLE, MiniSShot flight with AeroLab Cd vs Mach  
 UNITS, ENGLISH  
 STAGES, 2  
 Cd1, .6300 ,mach, .0000  
 Cd2, .6080 ,mach, .7000  
 Cd3, .5700 ,mach, 1.0000  
 Cd4, .8850 ,mach, 1.0700  
 Cd5, .6000 ,mach, 2.0000  
 STAGE1 MASS, .3830  
 STAGE2 MASS, 19.0000  
 STAGE1 DIA., 3.5500  
 STAGE2 DIA., 3.5500  
 SEP1 q, 210.0000

FILE, THR700.DAT  
 TITLE, ProtoSShot III 1st Phase data  
 UNITS, ENGLISH  
 Pmass, 11.53800  
 TIME STEP, .08333  
 DATA POINTS, 48  
 PRINTALL?, Yes  
 THRUST VALUE, 1, .0000  
 THRUST VALUE, 2, 56.0000  
 THRUST VALUE, 3, 60.0000  
 THRUST VALUE, 4, 234.0000  
 THRUST VALUE, 5, 426.0000  
 THRUST VALUE, 6, 536.0000  
 THRUST VALUE, 7, 488.0000  
 THRUST VALUE, 8, 472.0000  
 THRUST VALUE, 9, 477.0000

THRUST VALUE,	10,	473.0000
THRUST VALUE,	11,	465.0000
THRUST VALUE,	12,	466.0000
THRUST VALUE,	13,	468.0000
THRUST VALUE,	14,	480.0000
THRUST VALUE,	15,	478.0000
THRUST VALUE,	16,	483.0000
THRUST VALUE,	17,	477.0000
THRUST VALUE,	18,	493.0000
THRUST VALUE,	19,	489.0000
THRUST VALUE,	20,	488.0000
THRUST VALUE,	21,	488.0000
THRUST VALUE,	22,	488.0000
THRUST VALUE,	23,	481.0000
THRUST VALUE,	24,	483.0000
THRUST VALUE,	25,	485.0000
THRUST VALUE,	26,	480.0000
THRUST VALUE,	27,	478.0000
THRUST VALUE,	28,	476.0000
THRUST VALUE,	29,	469.0000
THRUST VALUE,	30,	477.0000
THRUST VALUE,	31,	469.0000
THRUST VALUE,	32,	456.0000
THRUST VALUE,	33,	454.0000
THRUST VALUE,	34,	443.0000
THRUST VALUE,	35,	437.0000
THRUST VALUE,	36,	418.0000
THRUST VALUE,	37,	416.0000
THRUST VALUE,	38,	395.0000
THRUST VALUE,	39,	383.0000
THRUST VALUE,	40,	372.0000
THRUST VALUE,	41,	335.0000
THRUST VALUE,	42,	266.0000
THRUST VALUE,	43,	210.0000
THRUST VALUE,	44,	151.0000
THRUST VALUE,	45,	102.0000
THRUST VALUE,	46,	57.0000
THRUST VALUE,	47,	32.0000
THRUST VALUE,	48,	.0000

FILE,	THR701.DAT	
TITLE,	ProtoSShot III Phase 2 data	
UNITS,	ENGLISH	
Pmass,	11.576000	
TIME STEP,	.08333	
DATA POINTS,	54	
PRINTALL?,	Yes	
THRUST VALUE,	1,	.0000
THRUST VALUE,	2,	24.0000
THRUST VALUE,	3,	22.0000
THRUST VALUE,	4,	20.0000
THRUST VALUE,	5,	30.0000
THRUST VALUE,	6,	108.0000
THRUST VALUE,	7,	192.0000
THRUST VALUE,	8,	332.0000
THRUST VALUE,	9,	467.0000
THRUST VALUE,	10,	528.0000
THRUST VALUE,	11,	568.0000
THRUST VALUE,	12,	586.0000
THRUST VALUE,	13,	598.0000
THRUST VALUE,	14,	612.0000
THRUST VALUE,	15,	606.0000
THRUST VALUE,	16,	589.0000
THRUST VALUE,	17,	593.0000

THRUST VALUE,	18,	582.0000
THRUST VALUE,	19,	594.0000
THRUST VALUE,	20,	577.0000
THRUST VALUE,	21,	569.0000
THRUST VALUE,	22,	554.0000
THRUST VALUE,	23,	552.0000
THRUST VALUE,	24,	541.0000
THRUST VALUE,	25,	529.0000
THRUST VALUE,	26,	518.0000
THRUST VALUE,	27,	501.0000
THRUST VALUE,	28,	485.0000
THRUST VALUE,	29,	470.0000
THRUST VALUE,	30,	456.0000
THRUST VALUE,	31,	449.0000
THRUST VALUE,	32,	431.0000
THRUST VALUE,	33,	426.0000
THRUST VALUE,	34,	416.0000
THRUST VALUE,	35,	407.0000
THRUST VALUE,	36,	393.0000
THRUST VALUE,	37,	380.0000
THRUST VALUE,	38,	364.0000
THRUST VALUE,	39,	349.0000
THRUST VALUE,	40,	331.0000
THRUST VALUE,	41,	322.0000
THRUST VALUE,	42,	300.0000
THRUST VALUE,	43,	289.0000
THRUST VALUE,	44,	273.0000
THRUST VALUE,	45,	256.0000
THRUST VALUE,	46,	242.0000
THRUST VALUE,	47,	203.0000
THRUST VALUE,	48,	158.0000
THRUST VALUE,	49,	107.0000
THRUST VALUE,	50,	66.0000
THRUST VALUE,	51,	39.0000
THRUST VALUE,	52,	17.0000
THRUST VALUE,	53,	11.0000
THRUST VALUE,	54,	.0000

\*\*\*\*\* END OF PRINTOUT \*\*\*\*\*

**Appendix C**  
**SOAR Output, “Sharp Nosecone” Cd, metric units**

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Stage 1 Computed Propellant Specific Impulse =      1289.2   N-sec/kg
Stage 1 Computed Engine Total Impulse =           6747.7   N-sec
Stage 2 Computed Propellant Specific Impulse =      1343.0   N-sec/kg
Stage 2 Computed Engine Total Impulse =           7052.3   N-sec
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## Stage 1:

Time sec.	Thrust N.	Altitude metres	Velocity m/sec.	Acceleration m/sec2	Mass kg.	Dyn.Press. kPa.	Drag N.
.000	.0	503.9	.00	-9.81	19.28	14.04	.0
.083	250.0	503.9	-.82	3.17	19.27	.00	.0
.167	268.0	503.8	-.55	4.11	19.25	.00	.0
.250	1040.0	503.8	-.21	44.33	19.21	.00	.0
.333	1893.0	503.9	3.48	89.22	19.12	.01	.0
.417	2382.0	504.5	10.91	115.70	18.98	.07	.2
.500	2172.0	505.8	20.55	105.50	18.83	.25	.7
.583	2098.0	507.9	29.34	102.36	18.69	.50	1.4
.666	2124.0	510.7	37.86	104.53	18.56	.84	2.4
.750	2104.0	514.2	46.57	104.23	18.42	1.26	3.6
.833	2066.0	518.5	55.25	102.91	18.28	1.78	5.1
.916	2074.0	523.4	63.81	104.08	18.15	2.37	6.8
1.000	2082.0	529.1	72.48	105.27	18.02	3.06	8.8
1.083	2135.0	535.5	81.24	108.98	17.88	3.84	11.0
1.166	2125.0	542.7	90.32	109.19	17.74	4.74	13.6
1.250	2151.0	550.6	99.41	111.44	17.60	5.74	16.5
1.333	2122.0	559.2	108.68	110.56	17.47	6.86	19.7
1.416	2193.0	568.7	117.88	115.42	17.33	8.06	23.2
1.499	2174.0	578.9	127.49	115.12	17.19	9.42	27.1
1.583	2172.0	589.9	137.07	115.78	17.05	10.87	31.3
1.666	2171.0	601.7	146.70	116.50	16.91	12.44	35.8
1.749	2169.0	614.3	156.39	117.15	16.76	14.12	40.6
1.833	2141.0	627.8	166.14	116.22	16.63	15.91	45.8
1.916	2149.0	642.0	175.81	117.44	16.49	17.79	51.2
1.999	2156.0	657.1	185.58	118.59	16.35	19.80	56.9
2.082	2137.0	672.9	195.44	118.14	16.21	21.92	63.0
2.166	2126.0	689.6	205.26	118.16	16.07	24.15	69.4
2.249	2116.0	707.1	215.09	118.22	15.93	26.47	76.0
2.332	2087.0	725.5	224.92	117.04	15.80	28.89	82.9
2.416	2122.0	744.6	234.65	119.92	15.66	31.39	90.1
2.499	2084.0	764.6	244.62	118.12	15.53	34.04	97.8
2.582	2029.0	785.4	254.44	115.14	15.39	36.76	105.6
2.666	2018.0	806.9	264.01	114.96	15.26	39.49	113.6
2.749	1972.0	829.3	273.56	112.43	15.13	42.31	122.1
2.832	1943.0	852.5	282.90	110.93	15.01	45.14	130.9
2.916	1860.0	876.5	292.12	105.69	14.88	48.02	140.8
2.999	1850.0	901.2	300.89	105.19	14.77	50.82	152.1
3.082	1758.0	926.6	309.61	98.78	14.65	53.68	167.4
3.165	1702.0	952.7	317.78	94.25	14.54	56.41	189.3
3.249	1656.0	979.5	325.54	89.40	14.43	59.04	224.7
3.332	1491.0	1006.9	332.83	74.42	14.33	61.55	284.4
3.415	1182.0	1034.9	338.93	51.12	14.24	63.65	314.4
3.499	936.0	1063.3	343.14	33.00	14.17	65.06	329.3
3.582	672.0	1092.0	345.86	13.89	14.12	65.91	337.4
3.665	454.0	1120.9	347.02	-1.62	14.08	66.16	338.7
3.749	254.0	1149.8	346.88	-15.75	14.06	65.92	337.5
3.832	145.0	1178.6	345.58	-23.26	14.05	65.25	334.0

3.915	.0	1207.3	343.66	-33.14	14.04	64.34	327.7
4.415	.0	1375.2	328.33	-27.14	14.04	57.76	243.5
4.915	.0	1536.2	316.13	-22.48	14.04	52.70	178.0
5.415	.0	1691.6	305.44	-20.47	14.04	48.45	149.8
5.915	.0	1841.8	295.52	-19.27	14.04	44.68	132.9
6.415	.0	1987.2	286.12	-18.40	14.04	41.27	120.6
6.915	.0	2128.0	277.10	-17.68	14.04	38.17	110.6
7.415	.0	2264.3	268.42	-17.06	14.04	35.33	101.9
7.915	.0	2396.4	260.03	-16.51	14.04	32.71	94.2
8.415	.0	2524.4	251.90	-16.01	14.04	30.30	87.1
8.915	.0	2648.4	244.01	-15.55	14.04	28.08	80.7
9.415	.0	2768.5	236.34	-15.13	14.04	26.02	74.7
9.915	.0	2884.8	228.88	-14.74	14.04	24.12	69.2
10.415	.0	2997.4	221.60	-14.37	14.04	22.35	64.1
10.915	.0	3106.4	214.50	-14.04	14.04	20.70	59.4
11.415	.0	3211.9	207.56	-13.73	14.04	19.18	55.0
11.915	.0	3314.0	200.77	-13.44	14.04	17.75	51.0
12.415	.0	3412.7	194.12	-13.17	14.04	16.43	47.2
12.915	.0	3508.1	187.60	-12.92	14.04	15.19	43.7
13.415	.0	3600.3	181.20	-12.68	14.04	14.04	40.4
13.915	.0	3689.3	174.91	-12.46	14.04	12.96	37.3
14.415	.0	3775.2	168.74	-12.25	14.04	11.95	34.4
14.915	.0	3858.1	162.66	-12.06	14.04	11.01	31.7

Stage 2:

Time sec.	Thrust N.	Altitude metres	Velocity m/sec.	Acceleration m/sec <sup>2</sup>	Mass kg.	Dyn.Press. kPa.	Drag N.
14.915	.0	3858.1	162.66	-12.09	13.87	8.62	31.7
14.998	108.0	3871.6	161.65	-4.27	13.87	10.86	31.2
15.082	99.0	3885.0	161.30	-4.90	13.86	10.80	31.0
15.165	90.0	3898.5	160.89	-5.54	13.85	10.73	30.8
15.248	135.0	3911.8	160.43	-2.27	13.85	10.65	30.6
15.332	480.0	3925.2	160.24	22.70	13.83	10.61	30.5
15.415	852.0	3938.6	162.13	49.73	13.79	10.85	31.2
15.498	1478.0	3952.3	166.27	95.58	13.71	11.39	32.8
15.582	2077.0	3966.5	174.22	140.23	13.60	12.49	35.9
15.665	2348.0	3981.5	185.88	161.52	13.47	14.20	40.8
15.748	2528.0	3997.5	199.32	176.54	13.32	16.29	46.8
15.831	2608.0	4014.7	214.01	184.34	13.16	18.75	53.8
15.915	2661.0	4033.2	229.34	190.26	12.99	21.49	61.7
15.998	2723.0	4053.0	245.16	197.01	12.83	24.51	70.4
16.081	2694.0	4074.1	261.54	196.69	12.66	27.83	80.2
16.165	2620.0	4096.5	277.89	192.60	12.49	31.34	91.5
16.248	2636.0	4120.4	293.88	195.35	12.33	34.97	106.5
16.331	2589.0	4145.5	310.06	191.58	12.17	38.82	138.6
16.414	2642.0	4172.0	325.78	192.74	12.01	42.74	210.3
16.498	2568.0	4199.8	341.71	186.75	11.84	46.88	240.0
16.581	2530.0	4228.9	357.19	184.32	11.69	51.07	261.4
16.664	2465.0	4259.3	372.47	179.42	11.53	55.35	283.1
16.748	2454.0	4291.0	387.34	179.13	11.38	59.66	304.2
16.831	2407.0	4323.8	402.18	175.62	11.23	64.09	325.2
16.914	2351.0	4357.9	416.74	171.22	11.08	68.57	345.3
16.998	2305.0	4393.3	430.93	167.66	10.94	73.04	364.3
17.081	2231.0	4429.7	444.82	161.42	10.79	77.53	382.6
17.164	2157.0	4467.3	458.20	155.02	10.66	81.93	400.2
17.247	2092.0	4506.0	471.05	149.27	10.53	86.24	417.3
17.331	2027.0	4545.8	483.41	143.28	10.40	90.44	435.0
17.414	1998.0	4586.6	495.28	140.68	10.27	94.52	451.8
17.497	1915.0	4628.3	506.93	132.67	10.15	98.58	468.4
17.581	1896.0	4671.0	517.92	130.90	10.03	102.43	484.0
17.664	1850.0	4714.6	528.76	126.37	9.92	106.27	499.3
17.747	1812.0	4759.1	539.23	122.58	9.81	109.99	513.9
17.831	1747.0	4804.4	549.38	115.92	9.69	113.62	528.1
17.914	1692.0	4850.6	558.98	110.21	9.59	117.04	541.2

17.997	1618.0	4897.5	568.10	102.42	9.49	120.28	553.5
18.080	1554.0	4945.2	576.59	95.59	9.39	123.27	564.7
18.164	1471.0	4993.6	584.50	86.63	9.29	126.02	574.8
18.247	1434.0	5042.5	591.68	82.60	9.20	128.45	583.6
18.330	1333.0	5092.1	598.52	71.49	9.12	130.74	591.7
18.414	1287.0	5142.2	604.45	66.41	9.04	132.62	598.3
18.497	1213.0	5192.8	609.95	58.17	8.96	134.31	604.0
18.580	1140.0	5243.8	614.78	50.00	8.89	135.69	608.6
18.664	1076.0	5295.2	618.93	42.83	8.82	136.76	611.9
18.747	903.0	5346.9	622.48	23.18	8.76	137.56	614.2
18.830	702.0	5398.8	624.42	.33	8.71	137.63	613.8
18.913	475.0	5450.8	624.46	-25.41	8.67	136.87	610.2
18.997	293.0	5502.8	622.38	-45.70	8.65	135.19	603.3
19.080	175.0	5554.5	618.62	-58.32	8.63	132.81	593.7
19.163	75.0	5605.8	613.81	-68.67	8.62	130.02	582.6
19.247	48.0	5656.7	608.15	-70.40	8.62	126.93	570.3
19.330	.0	5707.1	602.35	-74.55	8.62	123.83	558.0
19.830	.0	5999.3	567.18	-66.36	8.62	106.31	487.4
20.330	.0	6274.9	535.77	-59.51	8.62	92.00	428.3
20.830	.0	6535.6	507.50	-53.72	8.62	80.17	378.4
21.330	.0	6782.9	481.90	-48.79	8.62	70.31	336.0
21.830	.0	7017.9	458.59	-44.57	8.62	61.99	299.6
22.330	.0	7241.8	437.22	-41.05	8.62	54.93	269.3
22.830	.0	7455.4	417.47	-38.02	8.62	48.87	243.1
23.330	.0	7659.5	399.15	-35.30	8.62	43.63	219.7
23.830	.0	7854.8	382.13	-32.84	8.62	39.09	198.5
24.330	.0	8041.8	366.28	-30.62	8.62	35.14	179.3
24.830	.0	8221.2	351.48	-28.62	8.62	31.69	162.1
25.330	.0	8393.4	337.62	-26.83	8.62	28.65	146.7
25.830	.0	8559.0	324.62	-25.24	8.62	25.97	133.0
26.330	.0	8718.2	312.36	-23.76	8.62	23.60	120.2
26.830	.0	8871.5	301.05	-21.33	8.62	21.52	99.3
27.330	.0	9019.5	291.31	-18.11	8.62	19.80	71.6
27.830	.0	9163.0	282.66	-16.66	8.62	18.32	59.1
28.330	.0	9302.3	274.55	-15.82	8.62	16.99	51.9
28.830	.0	9437.6	266.79	-15.24	8.62	15.79	46.8
29.330	.0	9569.1	259.29	-14.78	8.62	14.67	42.9
29.830	.0	9696.9	252.00	-14.40	8.62	13.65	39.6
30.330	.0	9821.1	244.89	-14.06	8.62	12.69	36.6
30.830	.0	9941.8	237.93	-13.75	8.62	11.80	34.0
31.330	.0	10059.1	231.13	-13.47	8.62	10.98	31.6
31.830	.0	10173.0	224.46	-13.21	8.62	10.21	29.3
32.330	.0	10283.6	217.92	-12.97	8.62	9.49	27.3
32.830	.0	10390.9	211.49	-12.75	8.62	8.82	25.3
33.330	.0	10495.1	205.17	-12.54	8.62	8.19	23.5
33.830	.0	10596.1	198.95	-12.34	8.62	7.61	21.8
34.330	.0	10694.0	192.83	-12.16	8.62	7.05	20.2
34.830	.0	10788.9	186.79	-11.98	8.62	6.52	18.7
35.330	.0	10880.8	180.85	-11.82	8.62	6.03	17.3
35.830	.0	10969.8	174.98	-11.66	8.62	5.56	16.0
36.330	.0	11055.8	169.18	-11.52	8.62	5.13	14.8
36.830	.0	11139.0	163.46	-11.38	8.62	4.73	13.6
37.330	.0	11219.3	157.80	-11.26	8.62	4.35	12.5
37.830	.0	11296.8	152.20	-11.14	8.62	4.00	11.5
38.330	.0	11371.5	146.65	-11.03	8.62	3.67	10.6
38.830	.0	11443.5	141.16	-10.93	8.62	3.36	9.7
39.330	.0	11512.7	135.72	-10.83	8.62	3.08	8.8
39.830	.0	11579.2	130.33	-10.74	8.62	2.81	8.1
40.330	.0	11643.0	124.98	-10.66	8.62	2.56	7.3
40.830	.0	11704.2	119.67	-10.58	8.62	2.32	6.7
41.330	.0	11762.7	114.40	-10.51	8.62	2.10	6.0
41.830	.0	11818.6	109.16	-10.44	8.62	1.90	5.5
42.330	.0	11871.8	103.96	-10.38	8.62	1.71	4.9
42.830	.0	11922.5	98.78	-10.32	8.62	1.53	4.4

43.330	.0	11970.6	93.64	-10.26	8.62	1.36	3.9
43.830	.0	12016.2	88.52	-10.21	8.62	1.21	3.5
44.330	.0	12059.2	83.43	-10.16	8.62	1.07	3.1
44.830	.0	12099.6	78.36	-10.12	8.62	.94	2.7
45.330	.0	12137.5	73.31	-10.08	8.62	.81	2.3
45.830	.0	12172.9	68.28	-10.04	8.62	.70	2.0
46.330	.0	12205.8	63.27	-10.01	8.62	.60	1.7
46.830	.0	12236.2	58.27	-9.98	8.62	.51	1.5
47.330	.0	12264.1	53.29	-9.95	8.62	.42	1.2
47.830	.0	12289.5	48.32	-9.92	8.62	.35	1.0
48.330	.0	12312.4	43.37	-9.90	8.62	.28	.8
48.830	.0	12332.9	38.42	-9.88	8.62	.22	.6
49.330	.0	12350.8	33.49	-9.86	8.62	.16	.5
49.830	.0	12366.3	28.56	-9.85	8.62	.12	.3
50.330	.0	12379.4	23.64	-9.83	8.62	.08	.2
50.830	.0	12390.0	18.73	-9.82	8.62	.05	.1
51.330	.0	12398.1	13.82	-9.82	8.62	.03	.1
51.830	.0	12403.8	8.91	-9.81	8.62	.01	.0
52.330	.0	12407.0	4.01	-9.81	8.62	.00	.0
52.830	.0	12407.8	-.90	-9.81	8.62	.00	.0
53.330	.0	12406.1	-5.80	-9.81	8.62	.00	.0
53.830	.0	12402.0	-10.70	-9.80	8.62	.02	.0
54.330	.0	12395.4	-15.60	-9.79	8.62	.04	.1
54.830	.0	12386.4	-20.50	-9.79	8.62	.06	.2
55.330	.0	12374.9	-25.39	-9.78	8.62	.09	.3
55.830	.0	12361.0	-30.27	-9.76	8.62	.13	.4
56.330	.0	12344.7	-35.15	-9.75	8.62	.18	.5
56.830	.0	12325.9	-40.02	-9.73	8.62	.24	.7
57.330	.0	12304.7	-44.87	-9.71	8.62	.30	.9
57.830	.0	12281.0	-49.72	-9.68	8.62	.37	1.1
58.330	.0	12254.9	-54.56	-9.66	8.62	.44	1.3
58.830	.0	12226.5	-59.38	-9.63	8.62	.53	1.5
59.330	.0	12195.6	-64.19	-9.60	8.62	.62	1.8
59.830	.0	12162.3	-68.98	-9.57	8.62	.72	2.1
60.330	.0	12126.6	-73.76	-9.53	8.62	.83	2.4
60.830	.0	12088.5	-78.51	-9.49	8.62	.94	2.7
61.330	.0	12048.1	-83.25	-9.45	8.62	1.06	3.1
61.830	.0	12005.3	-87.96	-9.41	8.62	1.20	3.4
62.330	.0	11960.1	-92.65	-9.36	8.62	1.34	3.8
62.830	.0	11912.6	-97.32	-9.31	8.62	1.49	4.3
63.330	.0	11862.8	-101.97	-9.26	8.62	1.64	4.7
63.830	.0	11810.7	-106.58	-9.20	8.62	1.81	5.2
64.330	.0	11756.2	-111.17	-9.14	8.62	1.99	5.7
64.830	.0	11699.5	-115.72	-9.08	8.62	2.17	6.2
65.330	.0	11640.5	-120.25	-9.02	8.62	2.37	6.8
65.830	.0	11579.3	-124.74	-8.95	8.62	2.57	7.4
66.330	.0	11515.8	-129.20	-8.88	8.62	2.79	8.0
66.830	.0	11450.1	-133.62	-8.80	8.62	3.01	8.7
67.330	.0	11382.2	-138.00	-8.72	8.62	3.25	9.3
67.830	.0	11312.1	-142.34	-8.64	8.62	3.49	10.0
68.330	.0	11239.8	-146.64	-8.56	8.62	3.75	10.8
68.830	.0	11165.4	-150.90	-8.47	8.62	4.01	11.5
69.330	.0	11088.9	-155.11	-8.37	8.62	4.29	12.3
69.830	.0	11010.3	-159.27	-8.28	8.62	4.58	13.2
70.330	.0	10929.7	-163.38	-8.18	8.62	4.88	14.0
70.830	.0	10847.0	-167.45	-8.07	8.62	5.19	14.9
71.330	.0	10762.2	-171.46	-7.97	8.62	5.52	15.9
71.830	.0	10675.5	-175.41	-7.85	8.62	5.85	16.8
72.330	.0	10586.8	-179.31	-7.74	8.62	6.19	17.8
72.830	.0	10496.2	-183.16	-7.63	8.62	6.53	18.7
73.330	.0	10403.7	-186.94	-7.52	8.62	6.88	19.7
73.830	.0	10309.3	-190.67	-7.39	8.62	7.24	20.8
74.330	.0	10213.0	-194.34	-7.27	8.62	7.61	21.9
74.830	.0	10115.0	-197.94	-7.14	8.62	8.00	23.0

75.330	.0	10015.1	-201.48	-7.01	8.62	8.39	24.1
75.830	.0	9913.5	-204.95	-6.88	8.62	8.79	25.2
76.330	.0	9810.2	-208.36	-6.74	8.62	9.20	26.4
76.830	.0	9705.1	-211.69	-6.60	8.62	9.62	27.6
77.330	.0	9598.5	-214.96	-6.46	8.62	10.05	28.9
77.830	.0	9490.2	-218.15	-6.31	8.62	10.49	30.1
78.330	.0	9380.3	-221.27	-6.16	8.62	10.93	31.4
78.830	.0	9268.9	-224.31	-6.01	8.62	11.39	32.7
79.330	.0	9156.0	-227.28	-5.85	8.62	11.85	34.1
79.830	.0	9041.7	-230.17	-5.70	8.62	12.33	35.4
80.330	.0	8925.9	-232.98	-5.53	8.62	12.81	36.8
80.830	.0	8808.7	-235.70	-5.37	8.62	13.29	38.2
81.330	.0	8690.2	-238.35	-5.20	8.62	13.79	39.7
81.830	.0	8570.4	-240.91	-5.04	8.62	14.28	41.1
82.330	.0	8449.3	-243.38	-4.86	8.62	14.79	42.6
82.830	.0	8327.0	-245.77	-4.69	8.62	15.30	44.1
83.330	.0	8203.5	-248.07	-4.51	8.62	15.82	45.6
83.830	.0	8079.0	-250.28	-4.34	8.62	16.34	47.2
84.330	.0	7953.3	-252.41	-4.16	8.62	16.86	48.7
84.830	.0	7826.6	-254.44	-3.97	8.62	17.39	50.3
85.330	.0	7698.9	-256.38	-3.79	8.62	17.92	51.8
85.830	.0	7570.2	-258.23	-3.61	8.62	18.45	53.4
86.330	.0	7440.6	-259.98	-3.42	8.62	18.98	55.0
86.830	.0	7310.2	-261.65	-3.23	8.62	19.52	56.6
87.330	.0	7179.0	-263.22	-3.05	8.62	20.05	58.3
87.830	.0	7047.0	-264.69	-2.86	8.62	20.58	59.9
88.330	.0	6914.3	-266.08	-2.67	8.62	21.12	61.5
88.830	.0	6781.0	-267.37	-2.49	8.62	21.65	63.1
89.330	.0	6647.0	-268.57	-2.30	8.62	22.17	64.7
89.830	.0	6512.4	-269.67	-2.12	8.62	22.70	66.3
90.330	.0	6377.3	-270.68	-1.94	8.62	23.22	67.8
90.830	.0	6241.7	-271.61	-1.76	8.62	23.73	69.4
91.330	.0	6105.7	-272.44	-1.58	8.62	24.24	70.9
91.830	.0	5969.3	-273.19	-1.41	8.62	24.75	72.4
92.330	.0	5832.6	-273.85	-1.23	8.62	25.24	73.9
92.830	.0	5695.5	-274.42	-1.07	8.62	25.73	75.3
93.330	.0	5558.2	-274.91	-.90	8.62	26.22	76.7
93.830	.0	5420.6	-275.32	-.74	8.62	26.70	78.1
94.330	.0	5282.8	-275.65	-.58	8.62	27.16	79.5
94.830	.0	5144.9	-275.91	-.43	8.62	27.62	80.8
95.330	.0	5006.9	-276.09	-.28	8.62	28.08	82.1
95.830	.0	4868.9	-276.19	-.14	8.62	28.52	83.3
96.330	.0	4730.8	-276.22	.00	8.62	28.95	84.5
96.830	.0	4592.7	-276.19	.14	8.62	29.37	85.7
97.330	.0	4454.6	-276.08	.27	8.62	29.79	86.9
97.830	.0	4316.6	-275.92	.40	8.62	30.19	88.0
98.330	.0	4178.7	-275.68	.52	8.62	30.58	89.0
98.830	.0	4040.9	-275.39	.65	8.62	30.96	90.1
99.330	.0	3903.3	-275.04	.76	8.62	31.34	91.1
99.830	.0	3765.9	-274.63	.87	8.62	31.70	92.0
100.330	.0	3628.7	-274.17	.98	8.62	32.04	93.0
100.830	.0	3491.7	-273.65	1.09	8.62	32.38	93.9
101.330	.0	3355.0	-273.08	1.19	8.62	32.71	94.8
101.830	.0	3218.7	-272.46	1.29	8.62	33.02	95.6
102.330	.0	3082.6	-271.79	1.38	8.62	33.32	96.4
102.830	.0	2946.9	-271.08	1.47	8.62	33.62	97.2
103.330	.0	2811.5	-270.32	1.56	8.62	33.89	97.9
103.830	.0	2676.6	-269.53	1.64	8.62	34.16	98.6
104.330	.0	2542.0	-268.69	1.72	8.62	34.42	99.3
104.830	.0	2407.9	-267.81	1.79	8.62	34.66	100.0
105.330	.0	2274.2	-266.89	1.87	8.62	34.89	100.6
105.830	.0	2141.0	-265.94	1.93	8.62	35.11	101.2
106.330	.0	2008.3	-264.96	2.00	8.62	35.32	101.7
106.830	.0	1876.0	-263.94	2.06	8.62	35.52	102.3

107.330	.0	1744.3	-262.90	2.12	8.62	35.70	102.8
107.830	.0	1613.1	-261.83	2.17	8.62	35.88	103.2
108.330	.0	1482.5	-260.73	2.22	8.62	36.04	103.7
108.830	.0	1352.4	-259.60	2.27	8.62	36.19	104.1
109.330	.0	1222.9	-258.45	2.32	8.62	36.33	104.5
109.830	.0	1094.0	-257.29	2.36	8.62	36.47	104.8
110.330	.0	965.6	-256.10	2.40	8.62	36.59	105.2
110.830	.0	837.9	-254.89	2.43	8.62	36.70	105.5
111.330	.0	710.7	-253.67	2.46	8.62	36.80	105.7
111.830	.0	584.2	-252.43	2.49	8.62	36.89	106.0
112.330	.0	458.3	-251.17	2.52	8.62	36.97	106.2
112.830	.0	333.0	-249.91	2.54	8.62	37.05	106.4
113.330	.0	208.4	-248.63	2.56	8.62	37.11	106.6
113.830	.0	84.4	-247.35	2.58	8.62	37.17	106.8
114.330	.0	-38.9	-246.05	2.60	8.62	37.22	106.9

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Maximum altitude: 12407.8 metres

Maximum velocity: 624.46 metres/sec.

Maximum acceleration: 197.01 metres/sec<sup>2</sup>

Minimum acceleration: -74.550 metres/sec<sup>2</sup>

Maximum Mach number : 1.96 at 18.91 sec.

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ECHO OF INPUT DATA:

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FILE,          RCON704.DAT
TITLE,         MiniSShot flight
UNITS,         S.I.
STAGES,        2
Cd:,           Standard for sharp nose rocket
STAGE1 MASS,   .1740
STAGE2 MASS,   8.6180
STAGE1 DIA.,   9.0200
STAGE2 DIA.,   9.0200
SEPl q,        11.5000

FILE,          THR704.DAT
TITLE,         ProtoSShot III 1st phase data (Newtons)
UNITS,         S.I.
Pmass,         5.234000
TIME STEP,     .08333
DATA POINTS,   48
PRINTALL?,     Yes
THRUST VALUE,  1,          .0000
THRUST VALUE,  2,          250.0000
THRUST VALUE,  3,          268.0000
THRUST VALUE,  4,          1040.0000
THRUST VALUE,  5,          1893.0000
THRUST VALUE,  6,          2382.0000
THRUST VALUE,  7,          2172.0000
THRUST VALUE,  8,          2098.0000
THRUST VALUE,  9,          2124.0000
THRUST VALUE, 10,         2104.0000
THRUST VALUE, 11,         2066.0000
THRUST VALUE, 12,         2074.0000
THRUST VALUE, 13,         2082.0000
THRUST VALUE, 14,         2135.0000
THRUST VALUE, 15,         2125.0000
THRUST VALUE, 16,         2151.0000

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THRUST VALUE,	17,	2122.0000
THRUST VALUE,	18,	2193.0000
THRUST VALUE,	19,	2174.0000
THRUST VALUE,	20,	2172.0000
THRUST VALUE,	21,	2171.0000
THRUST VALUE,	22,	2169.0000
THRUST VALUE,	23,	2141.0000
THRUST VALUE,	24,	2149.0000
THRUST VALUE,	25,	2156.0000
THRUST VALUE,	26,	2137.0000
THRUST VALUE,	27,	2126.0000
THRUST VALUE,	28,	2116.0000
THRUST VALUE,	29,	2087.0000
THRUST VALUE,	30,	2122.0000
THRUST VALUE,	31,	2084.0000
THRUST VALUE,	32,	2029.0000
THRUST VALUE,	33,	2018.0000
THRUST VALUE,	34,	1972.0000
THRUST VALUE,	35,	1943.0000
THRUST VALUE,	36,	1860.0000
THRUST VALUE,	37,	1850.0000
THRUST VALUE,	38,	1758.0000
THRUST VALUE,	39,	1702.0000
THRUST VALUE,	40,	1656.0000
THRUST VALUE,	41,	1491.0000
THRUST VALUE,	42,	1182.0000
THRUST VALUE,	43,	936.0000
THRUST VALUE,	44,	672.0000
THRUST VALUE,	45,	454.0000
THRUST VALUE,	46,	254.0000
THRUST VALUE,	47,	145.0000
THRUST VALUE,	48,	.0000

FILE,	THR705.DAT	
TITLE,	ProtoSShot III 2nd phase data (Newtons)	
UNITS,	S.I.	
Pmass,	5.251000	
TIME STEP,	.08333	
DATA POINTS,	54	
PRINTALL?,	Yes	
THRUST VALUE,	1,	.0000
THRUST VALUE,	2,	108.0000
THRUST VALUE,	3,	99.0000
THRUST VALUE,	4,	90.0000
THRUST VALUE,	5,	135.0000
THRUST VALUE,	6,	480.0000
THRUST VALUE,	7,	852.0000
THRUST VALUE,	8,	1478.0000
THRUST VALUE,	9,	2077.0000
THRUST VALUE,	10,	2348.0000
THRUST VALUE,	11,	2528.0000
THRUST VALUE,	12,	2608.0000
THRUST VALUE,	13,	2661.0000
THRUST VALUE,	14,	2723.0000
THRUST VALUE,	15,	2694.0000
THRUST VALUE,	16,	2620.0000
THRUST VALUE,	17,	2636.0000
THRUST VALUE,	18,	2589.0000
THRUST VALUE,	19,	2642.0000
THRUST VALUE,	20,	2568.0000
THRUST VALUE,	21,	2530.0000
THRUST VALUE,	22,	2465.0000
THRUST VALUE,	23,	2454.0000
THRUST VALUE,	24,	2407.0000

THRUST VALUE,	25,	2351.0000
THRUST VALUE,	26,	2305.0000
THRUST VALUE,	27,	2231.0000
THRUST VALUE,	28,	2157.0000
THRUST VALUE,	29,	2092.0000
THRUST VALUE,	30,	2027.0000
THRUST VALUE,	31,	1998.0000
THRUST VALUE,	32,	1915.0000
THRUST VALUE,	33,	1896.0000
THRUST VALUE,	34,	1850.0000
THRUST VALUE,	35,	1812.0000
THRUST VALUE,	36,	1747.0000
THRUST VALUE,	37,	1692.0000
THRUST VALUE,	38,	1618.0000
THRUST VALUE,	39,	1554.0000
THRUST VALUE,	40,	1471.0000
THRUST VALUE,	41,	1434.0000
THRUST VALUE,	42,	1333.0000
THRUST VALUE,	43,	1287.0000
THRUST VALUE,	44,	1213.0000
THRUST VALUE,	45,	1140.0000
THRUST VALUE,	46,	1076.0000
THRUST VALUE,	47,	903.0000
THRUST VALUE,	48,	702.0000
THRUST VALUE,	49,	475.0000
THRUST VALUE,	50,	293.0000
THRUST VALUE,	51,	175.0000
THRUST VALUE,	52,	75.0000
THRUST VALUE,	53,	48.0000
THRUST VALUE,	54,	.0000

\*\*\*\*\* END OF PRINTOUT \*\*\*\*\*

**Appendix D**  
**SOAR Output, AeroLab Cd, metric units**

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SOAR Output File: SOAR705.OUT                               Opt:1
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Stage 1  Computed Propellant Specific Impulse =           1289.2  N-sec/kg
Stage 1  Computed Engine Total Impulse =                   6747.7  N-sec
Stage 2  Computed Propellant Specific Impulse =           1343.0  N-sec/kg
Stage 2  Computed Engine Total Impulse =                   7052.3  N-sec

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Stage 1:

Time sec.	Thrust N.	Altitude metres	Velocity m/sec.	Acceleration m/sec <sup>2</sup>	Mass kg.	Dyn.Press. kPa.	Drag N.
.000	.0	503.9	.00	-9.81	19.28	14.04	.0
.083	250.0	503.9	-.82	3.17	19.27	.00	.0
.167	268.0	503.8	-.55	4.11	19.25	.00	.0
.250	1040.0	503.8	-.21	44.33	19.21	.00	.0
.333	1893.0	503.9	3.48	89.22	19.12	.01	.0
.417	2382.0	504.5	10.91	115.70	18.98	.07	.3
.500	2172.0	505.8	20.55	105.49	18.83	.25	1.0
.583	2098.0	507.9	29.34	102.33	18.69	.50	2.0
.666	2124.0	510.7	37.86	104.48	18.56	.84	3.3
.750	2104.0	514.2	46.56	104.15	18.42	1.26	5.1
.833	2066.0	518.5	55.23	102.80	18.28	1.78	7.1
.916	2074.0	523.4	63.79	103.94	18.15	2.37	9.4
1.000	2082.0	529.1	72.44	105.08	18.02	3.05	12.2
1.083	2135.0	535.5	81.18	108.75	17.88	3.83	15.2
1.166	2125.0	542.6	90.23	108.90	17.74	4.73	18.8
1.250	2151.0	550.5	99.30	111.09	17.60	5.73	22.7
1.333	2122.0	559.2	108.54	110.13	17.47	6.84	27.1
1.416	2193.0	568.6	117.70	114.93	17.33	8.03	31.8
1.499	2174.0	578.8	127.26	114.54	17.19	9.38	37.1
1.583	2172.0	589.8	136.79	115.11	17.05	10.83	42.7
1.666	2171.0	601.6	146.37	115.73	16.91	12.38	48.8
1.749	2169.0	614.2	155.99	116.28	16.76	14.05	55.2
1.833	2141.0	627.6	165.66	115.23	16.63	15.82	62.1
1.916	2149.0	641.8	175.24	116.33	16.49	17.68	69.3
1.999	2156.0	656.8	184.91	117.37	16.35	19.66	77.0
2.082	2137.0	672.6	194.67	116.78	16.21	21.75	85.1
2.166	2126.0	689.2	204.37	116.66	16.07	23.94	93.5
2.249	2116.0	706.7	214.07	116.57	15.93	26.22	102.2
2.332	2087.0	724.9	223.76	115.25	15.80	28.59	111.3
2.416	2122.0	743.9	233.33	117.97	15.66	31.04	120.6
2.499	2084.0	763.8	243.13	116.03	15.53	33.63	130.1
2.582	2029.0	784.4	252.77	112.93	15.39	36.28	139.5
2.666	2018.0	805.9	262.16	112.65	15.26	38.94	148.9
2.749	1972.0	828.1	271.51	110.03	15.13	41.68	158.4
2.832	1943.0	851.1	280.65	108.47	15.01	44.43	167.9
2.916	1860.0	874.9	289.66	103.23	14.88	47.22	177.4
2.999	1850.0	899.3	298.24	102.85	14.77	49.94	186.6
3.082	1758.0	924.5	306.78	96.84	14.65	52.71	195.9
3.165	1702.0	950.4	314.82	93.20	14.54	55.37	204.7
3.249	1656.0	977.0	322.56	90.19	14.43	57.98	213.2
3.332	1491.0	1004.2	330.05	78.80	14.33	60.54	221.5
3.415	1182.0	1031.9	336.59	57.13	14.24	62.79	228.7
3.499	936.0	1060.2	341.26	37.94	14.17	64.37	259.3
3.582	672.0	1088.7	344.36	17.87	14.12	65.36	281.2
3.665	454.0	1117.5	345.82	1.72	14.08	65.73	291.7
3.749	254.0	1146.3	345.96	-12.55	14.06	65.60	292.5
3.832	145.0	1175.1	344.94	-19.77	14.05	65.02	284.9
3.915	.0	1203.7	343.32	-29.26	14.04	64.24	273.2

4.415	.0	1372.0	330.17	-25.02	14.04	58.43	213.6
4.915	.0	1534.0	317.97	-23.79	14.04	53.33	196.4
5.415	.0	1690.1	306.35	-22.68	14.04	48.74	180.8
5.915	.0	1840.5	295.27	-21.67	14.04	44.61	166.6
6.415	.0	1985.4	284.67	-20.75	14.04	40.86	153.6
6.915	.0	2125.2	274.51	-19.90	14.04	37.47	141.8
7.415	.0	2260.0	264.75	-19.13	14.04	34.38	130.9
7.915	.0	2390.0	255.37	-18.41	14.04	31.57	120.9
8.415	.0	2515.4	246.33	-17.76	14.04	29.01	111.7
8.915	.0	2636.4	237.60	-17.15	14.04	26.66	103.2
9.415	.0	2753.1	229.17	-16.59	14.04	24.51	95.2
9.915	.0	2865.6	221.01	-16.05	14.04	22.53	87.7
10.415	.0	2974.1	213.11	-15.55	14.04	20.72	80.7
10.915	.0	3078.8	205.45	-15.10	14.04	19.05	74.3
11.415	.0	3179.6	198.01	-14.68	14.04	17.51	68.4
11.915	.0	3276.8	190.77	-14.29	14.04	16.09	62.9
12.415	.0	3370.4	183.72	-13.93	14.04	14.78	57.8
12.915	.0	3460.5	176.84	-13.59	14.04	13.57	53.1
13.415	.0	3547.3	170.12	-13.28	14.04	12.44	48.8
13.915	.0	3630.7	163.56	-12.99	14.04	11.40	44.8
14.415	.0	3710.9	157.13	-12.73	14.04	10.44	41.0
14.915	.0	3787.8	150.83	-12.48	14.04	9.54	37.5

Stage 2:

Time sec.	Thrust N.	Altitude metres	Velocity m/sec.	Acceleration m/sec <sup>2</sup>	Mass kg.	Dyn.Press. kPa.	Drag N.
14.915	.0	3787.8	150.83	-12.51	13.87	8.62	37.5
14.998	108.0	3800.4	149.79	-4.68	13.87	9.39	37.0
15.082	99.0	3812.8	149.40	-5.31	13.86	9.33	36.7
15.165	90.0	3825.3	148.96	-5.94	13.85	9.27	36.5
15.248	135.0	3837.6	148.46	-2.67	13.85	9.19	36.2
15.332	480.0	3850.0	148.24	22.30	13.83	9.15	36.0
15.415	852.0	3862.4	150.09	49.32	13.79	9.37	36.9
15.498	1478.0	3875.1	154.20	95.14	13.71	9.88	38.8
15.582	2077.0	3888.3	162.11	139.73	13.60	10.90	42.8
15.665	2348.0	3902.3	173.73	160.92	13.47	12.50	49.0
15.748	2528.0	3917.3	187.11	175.80	13.32	14.48	56.6
15.831	2608.0	3933.5	201.73	183.45	13.16	16.80	65.6
15.915	2661.0	3950.9	216.98	189.19	12.99	19.40	75.5
15.998	2723.0	3969.7	232.70	195.78	12.83	22.28	86.3
16.081	2694.0	3989.7	248.98	195.33	12.66	25.45	97.5
16.165	2620.0	4011.1	265.21	191.17	12.49	28.81	109.2
16.248	2636.0	4033.9	281.09	194.16	12.33	32.28	121.1
16.331	2589.0	4058.0	297.23	191.99	12.17	36.00	133.6
16.414	2642.0	4083.4	313.18	198.07	12.01	39.86	146.3
16.498	2568.0	4110.2	329.60	191.84	11.84	44.03	179.8
16.581	2530.0	4138.3	345.29	184.09	11.69	48.18	264.2
16.664	2465.0	4167.7	360.51	178.66	11.53	52.36	291.9
16.748	2454.0	4198.3	375.32	178.60	11.38	56.57	310.2
16.831	2407.0	4230.2	390.13	175.31	11.23	60.91	328.5
16.914	2351.0	4263.3	404.67	171.11	11.08	65.31	346.4
16.998	2305.0	4297.6	418.86	167.71	10.94	69.71	363.8
17.081	2231.0	4333.1	432.77	161.61	10.79	74.14	380.5
17.164	2157.0	4369.7	446.17	155.37	10.66	78.50	396.4
17.247	2092.0	4407.4	459.05	149.84	10.53	82.76	411.4
17.331	2027.0	4446.2	471.47	144.19	10.40	86.95	425.6
17.414	1998.0	4485.9	483.43	141.95	10.27	91.03	438.8
17.497	1915.0	4526.7	495.20	134.33	10.15	95.10	451.5
17.581	1896.0	4568.4	506.35	132.98	10.03	98.98	463.1
17.664	1850.0	4611.0	517.38	128.89	9.92	102.88	474.3
17.747	1812.0	4654.6	528.07	125.56	9.81	106.67	484.7
17.831	1747.0	4699.0	538.49	119.40	9.69	110.40	494.4
17.914	1692.0	4744.3	548.40	114.18	9.59	113.94	503.2
17.997	1618.0	4790.4	557.87	106.88	9.49	117.33	511.2

18.080	1554.0	4837.2	566.74	100.54	9.39	120.49	518.2
18.164	1471.0	4884.8	575.09	92.06	9.29	123.43	524.3
18.247	1434.0	4933.0	582.74	88.49	9.20	126.08	529.4
18.330	1333.0	4981.8	590.09	77.84	9.12	128.60	533.9
18.414	1287.0	5031.3	596.56	73.16	9.04	130.74	537.3
18.497	1213.0	5081.2	602.64	65.30	8.96	132.70	540.2
18.580	1140.0	5131.6	608.07	57.47	8.89	134.36	542.2
18.664	1076.0	5182.5	612.85	50.60	8.82	135.74	543.4
18.747	903.0	5233.7	617.06	31.20	8.76	136.85	544.0
18.830	702.0	5285.2	619.66	8.46	8.71	137.23	543.0
18.913	475.0	5336.9	620.38	-17.33	8.67	136.78	540.3
18.997	293.0	5388.5	618.96	-37.87	8.65	135.39	535.6
19.080	175.0	5439.9	615.83	-50.88	8.63	133.28	529.5
19.163	75.0	5491.0	611.63	-61.69	8.62	130.73	522.4
19.247	48.0	5541.8	606.53	-63.94	8.62	127.85	514.6
19.330	.0	5592.1	601.24	-68.59	8.62	124.94	506.6
19.830	.0	5884.4	568.35	-63.05	8.62	108.11	458.8
20.330	.0	6160.9	538.11	-58.00	8.62	93.99	415.3
20.830	.0	6422.9	510.28	-53.43	8.62	82.09	375.9
21.330	.0	6671.5	484.61	-49.32	8.62	72.00	340.5
21.830	.0	6907.8	460.89	-45.62	8.62	63.40	308.7
22.330	.0	7132.7	438.92	-42.31	8.62	56.05	280.1
22.830	.0	7347.0	418.52	-39.34	8.62	49.73	254.5
23.330	.0	7551.4	399.53	-36.67	8.62	44.27	231.5
23.830	.0	7746.7	381.81	-34.27	8.62	39.52	210.9
24.330	.0	7933.4	365.22	-32.12	8.62	35.39	192.3
24.830	.0	8112.1	349.65	-30.18	8.62	31.76	175.6
25.330	.0	8283.2	335.01	-28.43	8.62	28.58	160.5
25.830	.0	8447.3	321.41	-24.87	8.62	25.80	129.8
26.330	.0	8605.1	310.04	-20.82	8.62	23.56	94.9
26.830	.0	8757.6	300.27	-19.01	8.62	21.70	79.3
27.330	.0	8905.4	290.93	-18.35	8.62	20.02	73.6
27.830	.0	9048.6	281.91	-17.74	8.62	18.47	68.4
28.330	.0	9187.3	273.18	-17.18	8.62	17.06	63.5
28.830	.0	9321.8	264.72	-16.65	8.62	15.76	59.0
29.330	.0	9452.1	256.52	-16.17	8.62	14.57	54.8
29.830	.0	9578.4	248.55	-15.72	8.62	13.47	51.0
30.330	.0	9700.7	240.79	-15.30	8.62	12.45	47.4
30.830	.0	9819.2	233.24	-14.92	8.62	11.52	44.0
31.330	.0	9934.0	225.87	-14.55	8.62	10.65	40.9
31.830	.0	10045.1	218.68	-14.22	8.62	9.84	38.0
32.330	.0	10152.7	211.65	-13.90	8.62	9.10	35.3
32.830	.0	10256.8	204.78	-13.60	8.62	8.41	32.7
33.330	.0	10357.5	198.05	-13.31	8.62	7.77	30.2
33.830	.0	10454.8	191.46	-13.05	8.62	7.17	27.9
34.330	.0	10548.9	185.00	-12.80	8.62	6.62	25.8
34.830	.0	10639.9	178.65	-12.57	8.62	6.10	23.8
35.330	.0	10727.6	172.42	-12.35	8.62	5.61	21.9
35.830	.0	10812.3	166.30	-12.14	8.62	5.15	20.2
36.330	.0	10893.9	160.28	-11.95	8.62	4.72	18.5
36.830	.0	10972.6	154.34	-11.78	8.62	4.33	17.0
37.330	.0	11048.3	148.50	-11.61	8.62	3.96	15.5
37.830	.0	11121.1	142.73	-11.46	8.62	3.62	14.2
38.330	.0	11191.0	137.04	-11.31	8.62	3.30	13.0
38.830	.0	11258.2	131.42	-11.18	8.62	3.00	11.8
39.330	.0	11322.5	125.86	-11.05	8.62	2.72	10.7
39.830	.0	11384.0	120.37	-10.94	8.62	2.47	9.7
40.330	.0	11442.8	114.93	-10.83	8.62	2.23	8.8
40.830	.0	11499.0	109.54	-10.73	8.62	2.01	7.9
41.330	.0	11552.4	104.20	-10.63	8.62	1.80	7.1
41.830	.0	11603.2	98.90	-10.55	8.62	1.61	6.4
42.330	.0	11651.3	93.65	-10.47	8.62	1.43	5.7
42.830	.0	11696.8	88.44	-10.39	8.62	1.27	5.0
43.330	.0	11739.7	83.26	-10.32	8.62	1.12	4.4

43.830	.0	11780.1	78.11	-10.26	8.62	.98	3.9
44.330	.0	11817.9	73.00	-10.20	8.62	.85	3.4
44.830	.0	11853.1	67.91	-10.14	8.62	.73	2.9
45.330	.0	11885.8	62.86	-10.09	8.62	.62	2.5
45.830	.0	11915.9	57.82	-10.05	8.62	.52	2.1
46.330	.0	11943.6	52.81	-10.01	8.62	.44	1.7
46.830	.0	11968.8	47.81	-9.97	8.62	.36	1.4
47.330	.0	11991.4	42.83	-9.94	8.62	.28	1.1
47.830	.0	12011.6	37.87	-9.91	8.62	.22	.9
48.330	.0	12029.3	32.92	-9.88	8.62	.17	.7
48.830	.0	12044.5	27.99	-9.86	8.62	.12	.5
49.330	.0	12057.3	23.06	-9.84	8.62	.08	.3
49.830	.0	12067.6	18.14	-9.83	8.62	.05	.2
50.330	.0	12075.4	13.23	-9.82	8.62	.03	.1
50.830	.0	12080.8	8.32	-9.81	8.62	.01	.0
51.330	.0	12083.7	3.42	-9.81	8.62	.00	.0
51.830	.0	12084.2	-1.49	-9.81	8.62	.00	.0
52.330	.0	12082.3	-6.39	-9.80	8.62	.01	.0
52.830	.0	12077.8	-11.29	-9.80	8.62	.02	.1
53.330	.0	12071.0	-16.19	-9.79	8.62	.04	.2
53.830	.0	12061.6	-21.08	-9.77	8.62	.07	.3
54.330	.0	12049.9	-25.96	-9.76	8.62	.10	.4
54.830	.0	12035.7	-30.83	-9.74	8.62	.15	.6
55.330	.0	12019.1	-35.70	-9.72	8.62	.20	.8
55.830	.0	12000.0	-40.55	-9.69	8.62	.25	1.0
56.330	.0	11978.5	-45.39	-9.66	8.62	.32	1.3
56.830	.0	11954.6	-50.21	-9.62	8.62	.39	1.6
57.330	.0	11928.3	-55.01	-9.59	8.62	.47	1.9
57.830	.0	11899.6	-59.79	-9.55	8.62	.56	2.2
58.330	.0	11868.5	-64.56	-9.50	8.62	.66	2.6
58.830	.0	11835.0	-69.30	-9.45	8.62	.76	3.0
59.330	.0	11799.2	-74.01	-9.40	8.62	.87	3.5
59.830	.0	11761.0	-78.70	-9.35	8.62	.99	4.0
60.330	.0	11720.5	-83.36	-9.29	8.62	1.12	4.5
60.830	.0	11677.7	-87.99	-9.23	8.62	1.26	5.0
61.330	.0	11632.5	-92.58	-9.16	8.62	1.40	5.6
61.830	.0	11585.1	-97.15	-9.09	8.62	1.56	6.2
62.330	.0	11535.4	-101.67	-9.02	8.62	1.72	6.8
62.830	.0	11483.4	-106.16	-8.94	8.62	1.89	7.5
63.330	.0	11429.2	-110.61	-8.86	8.62	2.07	8.2
63.830	.0	11372.8	-115.02	-8.77	8.62	2.26	8.9
64.330	.0	11314.2	-119.38	-8.68	8.62	2.45	9.7
64.830	.0	11253.5	-123.70	-8.59	8.62	2.66	10.5
65.330	.0	11190.5	-127.97	-8.49	8.62	2.88	11.3
65.830	.0	11125.5	-132.20	-8.39	8.62	3.10	12.2
66.330	.0	11058.4	-136.36	-8.29	8.62	3.33	13.1
66.830	.0	10989.1	-140.48	-8.18	8.62	3.58	14.1
67.330	.0	10917.9	-144.54	-8.06	8.62	3.83	15.0
67.830	.0	10844.6	-148.54	-7.94	8.62	4.09	16.0
68.330	.0	10769.3	-152.48	-7.82	8.62	4.36	17.1
68.830	.0	10692.1	-156.36	-7.70	8.62	4.64	18.2
69.330	.0	10613.0	-160.18	-7.57	8.62	4.92	19.3
69.830	.0	10532.0	-163.93	-7.44	8.62	5.21	20.4
70.330	.0	10449.1	-167.62	-7.31	8.62	5.50	21.5
70.830	.0	10364.4	-171.24	-7.17	8.62	5.80	22.7
71.330	.0	10277.8	-174.79	-7.04	8.62	6.11	23.9
71.830	.0	10189.6	-178.28	-6.89	8.62	6.43	25.1
72.330	.0	10099.6	-181.69	-6.75	8.62	6.75	26.4
72.830	.0	10007.9	-185.03	-6.60	8.62	7.08	27.6
73.330	.0	9914.6	-188.29	-6.45	8.62	7.42	28.9
73.830	.0	9819.6	-191.48	-6.30	8.62	7.76	30.2
74.330	.0	9723.1	-194.59	-6.14	8.62	8.11	31.6
74.830	.0	9625.0	-197.62	-5.98	8.62	8.47	33.0
75.330	.0	9525.5	-200.57	-5.82	8.62	8.83	34.4

75.830	.0	9424.5	-203.44	-5.66	8.62	9.19	35.8
76.330	.0	9322.1	-206.22	-5.49	8.62	9.57	37.2
76.830	.0	9218.3	-208.93	-5.32	8.62	9.94	38.6
77.330	.0	9113.2	-211.54	-5.15	8.62	10.32	40.1
77.830	.0	9006.8	-214.08	-4.98	8.62	10.71	41.6
78.330	.0	8899.1	-216.53	-4.82	8.62	11.10	43.0
78.830	.0	8790.2	-218.89	-4.65	8.62	11.49	44.5
79.330	.0	8680.2	-221.17	-4.48	8.62	11.88	45.9
79.830	.0	8569.1	-223.37	-4.30	8.62	12.28	47.4
80.330	.0	8456.9	-225.48	-4.13	8.62	12.68	48.9
80.830	.0	8343.6	-227.50	-3.96	8.62	13.09	50.4
81.330	.0	8229.4	-229.43	-3.78	8.62	13.49	51.9
81.830	.0	8114.2	-231.28	-3.61	8.62	13.89	53.4
82.330	.0	7998.1	-233.04	-3.43	8.62	14.30	54.9
82.830	.0	7881.2	-234.72	-3.26	8.62	14.70	56.4
83.330	.0	7763.4	-236.30	-3.09	8.62	15.11	57.9
83.830	.0	7644.9	-237.80	-2.91	8.62	15.51	59.4
84.330	.0	7525.6	-239.21	-2.74	8.62	15.92	60.9
84.830	.0	7405.7	-240.54	-2.56	8.62	16.32	62.4
85.330	.0	7285.1	-241.78	-2.39	8.62	16.71	63.9
85.830	.0	7163.9	-242.93	-2.22	8.62	17.11	65.4
86.330	.0	7042.2	-244.00	-2.05	8.62	17.50	66.9
86.830	.0	6919.9	-244.98	-1.88	8.62	17.89	68.3
87.330	.0	6797.2	-245.88	-1.71	8.62	18.27	69.7
87.830	.0	6674.1	-246.69	-1.55	8.62	18.65	71.2
88.330	.0	6550.5	-247.43	-1.38	8.62	19.03	72.6
88.830	.0	6426.7	-248.08	-1.22	8.62	19.39	74.0
89.330	.0	6302.5	-248.65	-1.06	8.62	19.75	75.3
89.830	.0	6178.0	-249.14	-.91	8.62	20.11	76.7
90.330	.0	6053.3	-249.56	-.75	8.62	20.46	78.0
90.830	.0	5928.5	-249.90	-.60	8.62	20.80	79.3
91.330	.0	5803.5	-250.16	-.45	8.62	21.13	80.6
91.830	.0	5678.3	-250.35	-.31	8.62	21.46	81.9
92.330	.0	5553.1	-250.47	-.17	8.62	21.78	83.1
92.830	.0	5427.9	-250.52	-.03	8.62	22.08	84.3
93.330	.0	5302.6	-250.49	.11	8.62	22.38	85.5
93.830	.0	5177.4	-250.41	.24	8.62	22.67	86.6
94.330	.0	5052.2	-250.25	.37	8.62	22.95	87.7
94.830	.0	4927.1	-250.04	.49	8.62	23.23	88.8
95.330	.0	4802.2	-249.76	.61	8.62	23.49	89.8
95.830	.0	4677.4	-249.42	.73	8.62	23.74	90.8
96.330	.0	4552.8	-249.03	.84	8.62	23.98	91.8
96.830	.0	4428.4	-248.58	.95	8.62	24.22	92.7
97.330	.0	4304.2	-248.08	1.06	8.62	24.44	93.6
97.830	.0	4180.3	-247.52	1.16	8.62	24.65	94.5
98.330	.0	4056.7	-246.92	1.26	8.62	24.85	95.3
98.830	.0	3933.4	-246.27	1.35	8.62	25.04	96.1
99.330	.0	3810.4	-245.57	1.44	8.62	25.22	96.9
99.830	.0	3687.8	-244.83	1.52	8.62	25.40	97.6
100.330	.0	3565.6	-244.05	1.60	8.62	25.56	98.3
100.830	.0	3443.8	-243.23	1.68	8.62	25.71	99.0
101.330	.0	3322.4	-242.37	1.75	8.62	25.85	99.6
101.830	.0	3201.4	-241.48	1.82	8.62	25.98	100.2
102.330	.0	3080.9	-240.55	1.89	8.62	26.11	100.8
102.830	.0	2960.9	-239.59	1.95	8.62	26.22	101.3
103.330	.0	2841.3	-238.60	2.00	8.62	26.33	101.8
103.830	.0	2722.3	-237.59	2.06	8.62	26.42	102.2
104.330	.0	2603.7	-236.55	2.11	8.62	26.51	102.7
104.830	.0	2485.7	-235.48	2.15	8.62	26.59	103.1
105.330	.0	2368.3	-234.40	2.19	8.62	26.66	103.4
105.830	.0	2251.3	-233.29	2.23	8.62	26.72	103.8
106.330	.0	2135.0	-232.16	2.27	8.62	26.78	104.0
106.830	.0	2019.2	-231.03	2.29	8.62	26.82	104.2
107.330	.0	1904.0	-229.88	2.31	8.62	26.87	104.4

107.830	.0	1789.3	-228.72	2.33	8.62	26.90	104.6
108.330	.0	1675.2	-227.55	2.35	8.62	26.93	104.7
108.830	.0	1561.8	-226.37	2.36	8.62	26.96	104.9
109.330	.0	1448.9	-225.19	2.37	8.62	26.97	105.0
109.830	.0	1336.6	-224.00	2.38	8.62	26.99	105.0
110.330	.0	1224.9	-222.81	2.39	8.62	27.00	105.1
110.830	.0	1113.8	-221.61	2.39	8.62	27.00	105.1
111.330	.0	1003.3	-220.41	2.40	8.62	27.00	105.2
111.830	.0	893.4	-219.22	2.40	8.62	27.00	105.2
112.330	.0	784.0	-218.02	2.40	8.62	26.99	105.2
112.830	.0	675.3	-216.82	2.39	8.62	26.98	105.1
113.330	.0	567.2	-215.63	2.39	8.62	26.96	105.1
113.830	.0	459.7	-214.43	2.38	8.62	26.94	105.1
114.330	.0	352.8	-213.24	2.38	8.62	26.92	105.0
114.830	.0	246.5	-212.06	2.37	8.62	26.90	104.9
115.330	.0	140.7	-210.88	2.36	8.62	26.87	104.8
115.830	.0	35.6	-209.70	2.35	8.62	26.84	104.7
116.330	.0	-69.0	-208.53	2.34	8.62	26.81	104.6

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Maximum altitude: 12084.2 metres

Maximum velocity: 620.38 metres/sec.

Maximum acceleration: 198.07 metres/sec<sup>2</sup>

Minimum acceleration: -68.594 metres/sec<sup>2</sup>

Maximum Mach number : 1.94 at 18.91 sec.

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ECHO OF INPUT DATA:

FILE, RCON705.DAT  
 TITLE, MiniSShot flight with AeroLab Cd vs Mach  
 UNITS, S.I.  
 STAGES, 2  
 Cd1, .6300 ,mach, .0000  
 Cd2, .6080 ,mach, .7000  
 Cd3, .5700 ,mach, 1.0000  
 Cd4, .8850 ,mach, 1.0700  
 Cd5, .6000 ,mach, 2.0000  
 STAGE1 MASS, .1740  
 STAGE2 MASS, 8.6180  
 STAGE1 DIA., 9.0200  
 STAGE2 DIA., 9.0200  
 SEP1 q, 10.0000

FILE, THR704.DAT  
 TITLE, ProtoSShot III 1st phase data (Newtons)  
 UNITS, S.I.  
 Pmass, 5.234000  
 TIME STEP, .08333  
 DATA POINTS, 48  
 PRINTALL?, Yes  
 THRUST VALUE, 1, .0000  
 THRUST VALUE, 2, 250.0000  
 THRUST VALUE, 3, 268.0000  
 THRUST VALUE, 4, 1040.0000  
 THRUST VALUE, 5, 1893.0000  
 THRUST VALUE, 6, 2382.0000  
 THRUST VALUE, 7, 2172.0000  
 THRUST VALUE, 8, 2098.0000  
 THRUST VALUE, 9, 2124.0000

THRUST VALUE,	10,	2104.0000
THRUST VALUE,	11,	2066.0000
THRUST VALUE,	12,	2074.0000
THRUST VALUE,	13,	2082.0000
THRUST VALUE,	14,	2135.0000
THRUST VALUE,	15,	2125.0000
THRUST VALUE,	16,	2151.0000
THRUST VALUE,	17,	2122.0000
THRUST VALUE,	18,	2193.0000
THRUST VALUE,	19,	2174.0000
THRUST VALUE,	20,	2172.0000
THRUST VALUE,	21,	2171.0000
THRUST VALUE,	22,	2169.0000
THRUST VALUE,	23,	2141.0000
THRUST VALUE,	24,	2149.0000
THRUST VALUE,	25,	2156.0000
THRUST VALUE,	26,	2137.0000
THRUST VALUE,	27,	2126.0000
THRUST VALUE,	28,	2116.0000
THRUST VALUE,	29,	2087.0000
THRUST VALUE,	30,	2122.0000
THRUST VALUE,	31,	2084.0000
THRUST VALUE,	32,	2029.0000
THRUST VALUE,	33,	2018.0000
THRUST VALUE,	34,	1972.0000
THRUST VALUE,	35,	1943.0000
THRUST VALUE,	36,	1860.0000
THRUST VALUE,	37,	1850.0000
THRUST VALUE,	38,	1758.0000
THRUST VALUE,	39,	1702.0000
THRUST VALUE,	40,	1656.0000
THRUST VALUE,	41,	1491.0000
THRUST VALUE,	42,	1182.0000
THRUST VALUE,	43,	936.0000
THRUST VALUE,	44,	672.0000
THRUST VALUE,	45,	454.0000
THRUST VALUE,	46,	254.0000
THRUST VALUE,	47,	145.0000
THRUST VALUE,	48,	.0000

FILE,	THR705.DAT	
TITLE,	ProtoSShot III 2nd phase data (Newtons)	
UNITS,	S.I.	
Pmass,	5.251000	
TIME STEP,	.08333	
DATA POINTS,	54	
PRINTALL?,	Yes	
THRUST VALUE,	1,	.0000
THRUST VALUE,	2,	108.0000
THRUST VALUE,	3,	99.0000
THRUST VALUE,	4,	90.0000
THRUST VALUE,	5,	135.0000
THRUST VALUE,	6,	480.0000
THRUST VALUE,	7,	852.0000
THRUST VALUE,	8,	1478.0000
THRUST VALUE,	9,	2077.0000
THRUST VALUE,	10,	2348.0000
THRUST VALUE,	11,	2528.0000
THRUST VALUE,	12,	2608.0000
THRUST VALUE,	13,	2661.0000
THRUST VALUE,	14,	2723.0000
THRUST VALUE,	15,	2694.0000
THRUST VALUE,	16,	2620.0000
THRUST VALUE,	17,	2636.0000

THRUST VALUE,	18,	2589.0000
THRUST VALUE,	19,	2642.0000
THRUST VALUE,	20,	2568.0000
THRUST VALUE,	21,	2530.0000
THRUST VALUE,	22,	2465.0000
THRUST VALUE,	23,	2454.0000
THRUST VALUE,	24,	2407.0000
THRUST VALUE,	25,	2351.0000
THRUST VALUE,	26,	2305.0000
THRUST VALUE,	27,	2231.0000
THRUST VALUE,	28,	2157.0000
THRUST VALUE,	29,	2092.0000
THRUST VALUE,	30,	2027.0000
THRUST VALUE,	31,	1998.0000
THRUST VALUE,	32,	1915.0000
THRUST VALUE,	33,	1896.0000
THRUST VALUE,	34,	1850.0000
THRUST VALUE,	35,	1812.0000
THRUST VALUE,	36,	1747.0000
THRUST VALUE,	37,	1692.0000
THRUST VALUE,	38,	1618.0000
THRUST VALUE,	39,	1554.0000
THRUST VALUE,	40,	1471.0000
THRUST VALUE,	41,	1434.0000
THRUST VALUE,	42,	1333.0000
THRUST VALUE,	43,	1287.0000
THRUST VALUE,	44,	1213.0000
THRUST VALUE,	45,	1140.0000
THRUST VALUE,	46,	1076.0000
THRUST VALUE,	47,	903.0000
THRUST VALUE,	48,	702.0000
THRUST VALUE,	49,	475.0000
THRUST VALUE,	50,	293.0000
THRUST VALUE,	51,	175.0000
THRUST VALUE,	52,	75.0000
THRUST VALUE,	53,	48.0000
THRUST VALUE,	54,	.0000

\*\*\*\*\* END OF PRINTOUT \*\*\*\*\*